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# SUGARBEET RESEARCH

1969 REPORT

COMPILED BY

SUGARBEET INVESTIGATIONS

CROPS RESEARCH DIVISION

AGRICULTURAL RESEARCH SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE

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A Report to and for  
the Sole Use of Cooperators  
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## FOREWORD

SUGARBEET RESEARCH is an annual compilation of the research accomplishments by staff members of Sugarbeet Investigations and Cooperators. The report is assembled by the Leader of Sugarbeet Investigations, is reproduced at the expense of the Beet Sugar Development Foundation, and is for the sole use of the cooperators. Much of the data has not been sufficiently confirmed to justify general release and interpretations may be modified with additional experimentation. The report is not intended for publication and should not be used for cited reference nor quoted in publicity or advertising. Reproduction of any portion of the material contained herein will not be permitted without the specific consent of the contributor or contributors.

The report presents results of investigations strengthened by contributions received under Cooperative Agreements between Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, and the Beet Sugar Development Foundation; the Farmers and Manufacturers Beet Sugar Association; Union Sugar Division, Consolidated Foods Corporation; the California Beet Growers Association, Ltd.; and the Red River Valley Sugarbeet Growers Association, Inc.

Trade names occur in this report solely to provide specific information and do not signify endorsement by the U.S. Department of Agriculture or the Beet Sugar Development Foundation.

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## NEW DEVELOPMENTS IN BREEDING RESEARCH

### Items Proposed for Seed Increase April 10, 1969

Breeder seed and inbred lines that have been developed in the breeding research conducted by the staff of Sugarbeet Investigations are proposed for seed production through the Beet Sugar Development Foundation. Seed not needed for planting overwintering plots will be furnished on request to company members of the Foundation for utilization in their breeding programs. Brief descriptions, current designations, and estimates of seed available August 1 are given for the items.

These new productions of breeding research have been developed by the staff of Sugarbeet Investigations in work conducted under Cooperative Agreements with:

California Agricultural Experiment Station  
Colorado Agricultural Experiment Station  
Michigan Agricultural Experiment Station  
Utah Agricultural Experiment Station  
Beet Sugar Development Foundation  
Farmers & Manufacturers Beet Sugar Association  
Union Sugar Division, Consolidated Foods Corp.  
California Beet Growers Association

### Items Proposed for Seed Increase and Utilization

#### I. U.S. Agricultural Research Station, Salinas, California.

##### A. Developments in breeding research by J. S. McFarlane, I. O. Skoyen, and R. T. Lewellen:

Item 1. C813 Multigerm . . . . . 5 pounds

A yellows-resistant selection from US 75. Eight successive selections were made on the basis of root size and freedom from yellowing. High sucrose percentage was emphasized in the 7th and 8th successive selections. C813 was selected from C713 (Item 1, 1968) and is the last selection for yellows resistance that has been made from US 75. Hybrids utilizing C813 as the pollen parent are included in 1969 variety tests. Additional quantities of hybrid seed are currently being produced by the Foundation.

Suggested utilization: Use as a breeding line. C813 may be increased for use as a pollen parent, but we suggest that the decision await the results of current tests in the Imperial Valley.

Item 2. C904 Multigerm . . . . . 5 pounds

An increase of a cross between YRS 534 and YRS 413. YRS 534 is a Salinas selection from the most yellows resistant line furnished by Dr. Henk Rietberg of the Netherlands. YRS 413 is the 7th successive yellows resistant selection from US 75. C904 performed well in both yellows inoculated and noninoculated tests in 1968. The line has good bolting resistance but is poor in curly top resistance. The sucrose percentage is similar to that of the poorer parent. A test hybrid utilizing C904 as the pollen parent is included in 1969 variety tests.

Suggested utilization: Increase for possible use as a pollen parent and produce additional test quantities of hybrid seed. Preliminary performance information will be available from current tests in the Imperial Valley.

B. Developments in breeding and genetic research by V. F. and Helen Savitsky:

Item 3. S-112 Multigerm . . . . . 300 grams

Tetraploid self-sterile population; curly top resistant.

Item 4. S-5-692-1 Multigerm . . . . . 150 grams

Diploid self-sterile population of Polish origin, high in sucrose. Curly top susceptible.

Item 5. S-5-692-2 Multigerm . . . . . 400 grams

Tetraploid equivalent of S-5-692-1.

Item 6. S-130 Monogerm . . . . . 50 grams

Tetraploid self-fertile inbred. Resistant to curly top.

Item 7. S-4-603 Multigerm . . . . . 150 grams

Tetraploid self-sterile hybrid populations obtained from crosses between highly curly top resistant strains and tetraploid US 401 (LSR). Good in vigor.

Item 8. S-4-614 Multigerm . . . . . 150 grams

Similar to Item 7.



Item 9. S-4-513 Multigerm . . . . . 150 grams

Tetraploid self-sterile hybrid populations obtained from crosses between highly curly top resistant strains and high sucrose populations.

Item 10. S-4-551 Multigerm . . . . . 150 grams

Similar to Item 9.

II. Crops Research Laboratory, Colorado State University,  
Fort Collins, Colorado.

Developments in breeding research of J. O. Gaskill:

Item 11. FC 506 Monogerm . . . . . 5.0 pounds

Highly resistant to leaf spot; good type 0; rr; advanced generation of the cross, FC 504 sublines x FC 502/2. Results obtained in numerous tests have shown high sucrose yields and high sucrose percentages for hybrids having FC(504 x 502/2)-CMS as the female parent. Poor seed production of FC 502/2 in Oregon has been a deterrent to the use of the female, FC(504 x 502/2)-CMS. We believe that FC 506 offers a means of overcoming this problem.

Suggested utilization: Increase.

Item 12. FC 506-CMS Monogerm . . . . . 10.0 pounds

CMS equivalent of FC 506; rr.

Suggested utilization: Increase, using FC 506 as the pollinator.

Item 13. FC 902 Multigerm . . . . . 5.0 pounds

LSR-CTR; a pool of three  $S_1$  lines, derived from FC 901, using the reciprocal topcross technique for identification of superior genotypes. FC 902 is about equal to FC 901 in curly top resistance and much higher than FC 901 in leaf spot resistance. FC 902 is about equal to US 41 in curly top resistance. The hybrid, FC(504 x 502/2)-CMS x FC 902, was high in sucrose yield and percentage in the leaf spot field at Fort Collins in 1968.

Suggested utilization: Increase.

Item 14. FC 903 Multigerm . . . . . 5.0 pounds

LSR-CTR; bolting resistant; derived from FC 901, using the seedling induction technique for bolting resistance selection. FC 903 is a product of a single, open-pollinated plant that was brought to seed in a group of bolting resistant seedlings derived from the same source. FC 903 apparently is superior to US 41 in curly top resistance and superior to FC 901 in leaf spot resistance. The hybrid, FC(504 x 502/2)-CMS x FC 903, was high in sucrose yield and satisfactory in sucrose percentage in the leaf spot field at Fort Collins in 1968.

Suggested utilization: Increase.

(Seed of FC 903 is already on hand. Seed of FC 506, FC 506-CMS, and FC 902 should be ready for shipment by about August 10, 1969.)

### III. Plant Industry Station, Beltsville, Maryland.

Developments in breeding research by G. E. Coe:

Item 15. SP 67585-01 Monogerm . . . . . 1 pound

Male-sterile companion line to SP 67585-0 which is type O. This male-sterile phase is being made available for utilization, but the type O pollinator will be increased and rechecked for trueness to O-type and single-seededness at Beltsville. The seed production by the overwintering method will provide a seed increase of the male-sterile phase as well as the O-type. This line has exhibited good combining ability, but its leaf spot resistance is only slightly better than SL(129 x 133) X SP 6322-0.

Suggested utilization: Use in production of experimental hybrids.

Item 16. SP 683301-01 Monogerm . . . . . 1 pound

Male-sterile companion line of SP 683301-0 which is type O. The male-sterile phase is being made available for utilization, but the pollinator will be increased and rechecked for trueness to O-type at Beltsville. The seed



Item 16 (cont.)

production by the overwintering method will provide a seed increase of the male-sterile phase as well as the O-type. This line has exhibited good combining ability, but its leaf spot resistance is only slightly better than SL(129 x 133) X SP 6322-0.

Suggested utilization: Use in the production of experimental hybrids.

IV. Sugarbeet Investigations, East Lansing, Michigan.

Developments in breeding research by G. J. Hogaboam and R. C. Zielke:

Item 17. EL 36 Monogerm . . . . . 100 grams

A type O, open-pollinated, sibmated line of one progeny. Grandparent progeny was extremely high yielding (4 lbs. per foot of row). The parent progeny had the following characteristics: 81% of the processed fruits remained on an 8.5/64" round-hole screen; 2% double ovule; 0, 34, 63, and 71 percent germination after 3, 4, 5, and 6 days, respectively; 21.1 T/A, 14.8% sucrose, 94.1% clear juice purity--giving 260 lbs. recoverable sugar per ton and 5,753 lbs. sugar per acre. (Current breeder seed no.69B2-0.)

Suggested utilization: Increase.

Item 18. EL 36 C2 Monogerm . . . . . 50 grams

CMS equivalent of EL 36 from source 2 cytoplasm, represents the BC<sub>2</sub> generation. (Current breeder seed no. 69B2X01.)

Suggested utilization: Increase.

Item 19. EL 37 Monogerm . . . . . 100 grams

A type O, open-pollinated, sibmated line of one progeny. (A sister line of EL 36.) The parent progeny had the following characteristics: 69% of the processed fruits remained on an 8.5/64" round-hole screen; 3% double ovule; 0, 84, and 99 percent germination after 3, 4, and 5 days, respectively; 100 Aphanomyces rating (same as US 401);

Item 19 (cont.)

20.2 T/A, 15.5% sucrose, 93.9% clear juice purity--giving 271 lbs. recoverable sugar per ton and 5,465 lbs. recoverable sugar per acre. (Current breeder seed no. 69B3-0.)

Suggested utilization: Increase.

Item 20. 37 C2 Monogerm . . . . . 50 grams

CMS equivalent of EL 37 from source 2 cytoplasm; represents the BC<sub>2</sub> generation. (Breeder seed no. 69B3-01.)

Suggested utilization: Increase.

V. Crops Research Laboratory, Utah State University,  
Logan, Utah.

Developments in breeding research of J. C. Theurer  
and Associates:

Item 21. L-13 CMS Monogerm . . . . . 1 pound

Male-sterile equivalent (rr) of L-13, the BC<sub>2</sub> to SLC 129 CMS. L-13 (Item 10, 1965) is a type O sugar selection from SLC 129. (No. 813 CMS)

Suggested utilization: Use as a male-sterile parent in experimental hybrids.

Item 22. L-35 Monogerm . . . . . 200 grams

An S<sub>5</sub> inbred selection with high curly top resistance, rr; approaches type O. (No. 735)

Suggested utilization: Use as parent to increase curly top resistance.

UTILIZATION OF USDA SEED RELEASES, 1969

Item numbers and seed numbers are identical with those listed by the Leader, Sugarbeet Investigations, USDA, dated April 10, 1969 under subject "Proposals for Seed Production and Utilization."

I. U. S. Agricultural Research Station, Salinas, California.

A. Developments in breeding research by J. S. McFarlane, I. O. Skoyen and R. T. Lewellen.

Item 1. C813 Multigerm ..... 5.0 pounds

From the available amount of seed, a portion will be shared now among the following companies: Amalgamated, American Crystal, F & M, Holly Spreckels and Utah-Idaho. The balance of the seed will be used for an increase by the West Coast Beet Seed Company, the increase to be shared among the following companies: American Crystal, Great Western (50# only), Holly, Spreckels and Union.

Item 2. C904 Multigerm ..... 5.0 pounds

From the available amount of seed, a portion will be shared now among the following companies: Amalgamated, American Crystal, Holly, Spreckels and Utah-Idaho. The balance of the seed will be used for an increase by the West Coast Beet Seed Company, the increase to be shared among the following companies: American Crystal, Great Western (50# only), Spreckels and Union.

B. Developments in breeding and genetics research by V. F. and Helen Savitsky.

Item 3. S-112 Multigerm ..... 300 grams

The available quantity of seed will be shared now among the following companies: Amalgamated, American Crystal, Great Western, Holly, Spreckels, Union and Utah-Idaho.

Item 4. S-5-692-1 Multigerm ..... 150 grams

None of the available seed will be distributed among the companies at this time. An increase will be made by the West Coast Beet Seed Company to be shared by American Crystal and F & M.



Utilization of USDA Seed Releases, 1969  
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Item 5. S-5-692-2 Multigerm .....400 grams

From the available amount of seed, a portion will be shared now among the following companies: Amalgamated, American Crystal, F & M, Great Western, Holly, Spreckels, Union and Utah-Idaho. The balance of the seed will be used for an increase by the West Coast Beet Seed Company for F & M.

Item 6. S-130 Monogerm.....50 grams

The available quantity of seed will be shared now among the following companies: Amalgamated, Great Western, Holly, Spreckels, Union and Utah-Idaho.

Item 7. S-4-603 Multigerm.....150 grams

The available quantity of seed will be shared now among the following companies: Amalgamated, American Crystal, Great Western, Holly, Spreckels, Union and Utah-Idaho.

Item 8. S-4-614 Multigerm.....150 grams

The same utilization and distribution as noted for Item 6 will apply to this number.

Item 9. S-4-513 Multigerm .....150 grams

The same utilization and distribution as noted for Item 7 will apply to this number.

Item 10. S-4-551 Multigerm.....150 grams

The same utilization and distribution as noted for Item 6 will apply to this number.

II. Crops Research Laboratory, Colorado State University,  
Fort Collins, Colorado.

A. Developments in breeding research of J. O. Gaskill.

Item 11. FC 506 Monogerm.....5.0 pounds

From the available amount of seed, a portion will be shared now among the following companies: Amalgamated, American Crystal, F & M, Great Western, Holly, Spreckels and Utah-Idaho. The balance of the seed will be used for an increase by the West Coast Beet Seed Company, the increased to be shared among the following companies: American Crystal, F & M, Great Western, Holly and Spreckels.

Utilization of USDA Seed Releases, 1969  
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Item 12. FC 506 CMS Monogerm.....10.0 pounds

The same utilization and distribution as noted for Item 11 will apply to this number.

Item 13. FC 902 Multigerm.....5.0 pounds

From the available amount of seed, a portion will be shared now among the following companies: Amalgamated, American Crystal, Great Western, Holly, Spreckels, and Utah-Idaho. The balance of the seed will be used for an increase by the West Coast Beet Seed Company, the increase to be shared by American Crystal, F & M, Great Western and Spreckels.

Item 14. FC 903 Multigerm.....5.0 pounds

The same utilization and distribution as noted for Item 13 will apply to this number except Holly will also share in the increase.

III. Plant Industry Station, Beltsville, Maryland.

A. Developments in breeding research by G. E. Coe.

Item 15. SP 67585-01 Monogerm.....1.0 pound

The available quantity of seed will be shared now among the following companies: Amalgamated, American Crystal, Great Western, Holly, Spreckels and Utah-Idaho.

Item 16. SP 683301-01 Monogerm.....1.0 pound

The same utilization and distribution as noted for Item 15 will apply to this number.

IV. Sugarbeet Investigations, East Lansing, Michigan.

A. Developments in breeding research by G. J. Hogaboam and R. C. Zielke.

Item 17. EL 36 Monogerm.....100 grams

No utilization is to be made of this item until further developments are accomplished.

Item 18. EL 36 C2 Monogerm.....50 grams

Same utilization as stated for Item 17.

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Item 19. EL 37 Monogerm.....100 grams

Same utilization as stated for Item 17.

Item 20. 37 C2 Monogerm.....50 grams

Same utilization as stated for Item 17.

V. Crops Research Laboratory, Utah State University,  
Logan, Utah.

A. Developments in breeding research by J. C. Theurer  
and associates.

Item 21. L-13 CMS Monogerm.....1.0 pound

The available quantity of seed will be shared now  
among the following companies: Amalgamated, American  
Crystal, F & M, Great Western, Holly, Spreckels and  
Utah-Idaho.

Item 22. L-35 Monogerm.....200 grams

The available quantity of seed will be shared now  
among the following companies: Amalgamated, American  
Crystal, Great Western, Holly, Spreckels and Utah-Idaho.

Item 23. SP 6822-0<sup>1</sup>.....70 pounds

Enough of the available seed will be sent to the West  
Coast Beet Seed Company with which to plant 5 acres  
of increase for the following companies: American  
Crystal (2 acres), F & M (1 acre) and Great Western  
(2 acres). The balance of the seed will be shared  
now among the following companies: Amalgamated, Holly,  
Spreckels and Utah-Idaho.

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<sup>1</sup>This item was not listed in the "Proposals for Seed Product-  
ion and Utilization" but has been added to the list at the request  
of the interested member companies of the BSDF.



Disease Resistance Tests with Zwaanpoly

Compiled by J. S. McFarlane  
Leader, Sugarbeet Investigations  
Crops Research Division  
Agricultural Research Service  
U.S. Department of Agriculture  
Salinas, California

Curly top - Test by Dr. D. L. Mumford, Logan, Utah.

Very susceptible. The variety should not be used in areas subject to curly top damage.

Leaf spot - Tests by Dr. E. G. Ruppel, Fort Collins, Colorado, Dr. G. E. Coe, Beltsville, Maryland, and Dr. C. L. Schneider, East Lansing, Michigan.

Very susceptible. Damage can be expected when the variety is grown in areas subject to leaf spot.

Black root (*Aphanomyces cochlioides*) - Test by Dr. C. L. Schneider, East Lansing, Michigan.

Susceptible. Damage was much more severe on Zwaanpoly than on US H20 and other varieties that have been selected for resistance.

Rhizoctonia root rot - Tests by Mr. J. O. Gaskill, Fort Collins, Colorado and Dr. C. L. Schneider, East Lansing, Michigan.

Susceptible. The tests indicate that damage to Zwaanpoly is similar to that with other commercial varieties.

Virus yellows - Test by Dr. R. T. Lewellen at Davis, California.

Susceptible. Root yield was reduced 37% and sucrose content 2.11 percentage points. Losses with Zwaanpoly were similar to those with other commercial varieties that had not been selected for resistance.

Sugarbeet nematode - Test by Dr. D. L. Doney, Salinas, California.

Susceptible. Roots of Zwaanpoly were severely infested with nematodes, but the variety did yield well in heavily infested soil. The good performance is probably associated with high plant vigor.

ABSTRACTS OF PAPERS APPROVED FOR PUBLICATION IN 1969

BENNETT, C. W. and L. D. LEACH. Diseases and their control. In Advances in Sugarbeet Production: Principles and Practices. Chapter 9. Iowa State University Press, Ames, Iowa. (In press).

This chapter describes the bacterial, fungus, and virus diseases of sugarbeet and discusses their control.

DONEY, D. L., J. M. FIFE, and E. D. WHITNEY. The effect of the sugarbeet nematode *Heterodera schachtii* Schm. on the free amino acids in resistant and susceptible Beta species. Phytopathology. (In press).

Three separate experiments were conducted to measure the effect of *Heterodera schachtii* infection on the concentration of free amino acids in *Beta vulgaris* and *Beta patellaris* (a resistant species in which the nematode larvae invade the roots but do not mature). The concentration of free amino acids in the fibrous roots of *B. patellaris* was unchanged in nematode infected plants. But in the fibrous roots of nematode infected plants of *B. vulgaris*, concentrations of total amino acids, aspartic acid, glutamic acid, and glutamine were significantly increased.

DONEY, D. L. and E. D. WHITNEY. Screening sugarbeet for resistance to *Heterodera schachtii* Schm. J. Am. Soc. Sugar Beet Technol. 15(6): 546-552. 1969.

A technique was developed for counting white females of *Heterodera schachtii* Schm. on the soil-vial interface without disturbing the roots. Twenty-seven sugarbeet varieties and selections from different sources of origin were tested for a genotypic variance and number of white females. Differences between varieties were found in some tests, but these differences were not consistent from test to test. Selections did not have significantly fewer white females than their parents. Little genotypic variance for number of white females was observed.

DUFFUS, JAMES E. Membrane feeding used in determining the properties of beet western yellows virus. Phytopathology 59: 1668-1669. 1969.

The properties of beet western yellows virus (BWYV), a circulative aphid transmitted virus, were determined by feeding green peach aphids, *Myzus persicae*, through membranes on partially purified extracts of the virus subjected to various treatments. BWYV was infectious after 10 min at 60 C (but not 65 C). Extracts were infectious after 16 days at temperatures from 0 to 24 C, but not after 16 days. Alternate freezing and thawing at 4- or 5-day intervals for a month had no effect on virus activity. The maximum dilution of unconcentrated sap to show infectivity was 1:8. BWYV withstood drying and has remained active for at least 3 years.

DUFFUS, J. E. and G. E. RUSSELL. New or uncommon plant diseases and pests. Pl. Path. 18: 144. 1969.

Sowthistle yellow vein virus in England. Sowthistle yellow vein virus (SYVV), which induces a disease of sowthistle (Sonchus oleraceus L.) characterized by vein-clearing and vein-banding symptoms on the leaves, was first reported from California and Arizona in 1963; there appear to be no published reports of its occurrence outside the U.S.A. This virus has an unusually long latent period in its aphid vector, Hyperomyzus (Amphorophora) lactucae L., and its particles are bacilliform. Crude extracts from leaves of S. oleraceus were examined under the electron microscope using an epidermal-strip technique involving negative staining with 2 percent phosphotungstate. Bacilliform particles, whose morphology agreed closely with that described for SYVV in the U.S.A., were observed in preparations from plants showing vein-clearing symptoms.

DUFFUS, JAMES E. and F. W. ZINK. A diagnostic host reaction for the identification of turnip mosaic virus. Plant Dis. Repr. 53: 916-917. 1969.

A specific host reaction, capable of distinguishing isolates of turnip mosaic virus (TuMV), may prove of value as a diagnostic tool for the identification of this virus. All isolates of TuMV thus far collected from California growing ~~arens~~ induce infection on susceptible lettuce cultivars (Calmar, E-4, Imperial 410, Imperial Triumph, Valrio, Valtemp, and Valverde). Seventy-two other cultivars tested, including Great Lakes and Cos, were immune (extreme resistance) to TuMV.

FIFE, J. M. Selecting sugarbeet for yellows resistance on the relative concentration of three amino acids in leaves of infected plants. J. Am. Soc. Sugar Beet Technol. 15(4): 318-323. 1969.

Extensive testing of first and second successive sugarbeet selections, made on the basis of root weight and the magnitude of the amino acid ratio (concentration: aspartic acid + glutamic acid) in glutamine newly-matured leaves of beet yellows-infected plants, has shown a progressive increase in resistance to beet yellows over that of the parent variety, US 75. The second successive selections, when inoculated with the most virulent strain (Brawley) of beet yellows virus, were significantly more resistant to beet yellows than the parent variety as shown by superior yields and also by a highly significant increase in the percentage sucrose. The correlation between the amino acid ratio of the selections and the percentage sucrose is positive and highly significant. The correlation between the amino acid ratio and yield of beets is positive and significant at the 10% level in tests involving the second successive selections. The superior performance of the selections, over that of the parent variety, for a short growing season (160 to 180 days) suggests that early maturing varieties may be developed by selecting from yellows-infected populations on the basis of the amino acid ratio.



GASKILL, J. O. A preliminary report on the inheritance of Rhizoctonia resistance in sugarbeet. Proc. 15th Regional Meeting (Eastern U.S. and Eastern Canada) Am. Soc. Sugar Beet Technol., pp. 31-36. 1969.

A replicated field experiment was conducted at Fort Collins, Colorado, in 1968 as a part of a preliminary study of inheritance of resistance to Rhizoctonia root and crown rot in sugarbeet. The results for one F<sub>1</sub> hybrid (resistant x susceptible lines) indicated partial dominance for resistance. The resistance of a similar F<sub>1</sub> hybrid was loosely classed as intermediate. The results for a series of F<sub>3</sub> lines indicated, tentatively, that resistance can be transferred from resistant to susceptible material with relative ease.

GASKILL, J. O. Beets resistant to Rhizoctonia important goal of seed breeders. Through the Leaves 57(3): 8-9. 1969.

Two Rhizoctonia resistant sugarbeet lines--products of breeding work at Fort Collins, Colorado--have been officially released by the Crops Research Division, A.R.S., U.S.D.A. The two lines, FC 701 and FC 702, are not suitable for use as commercial varieties. They are considered of value, principally, as sources of genes for Rhizoctonia resistance in breeding work designed to combine resistance with high yield and other desirable characters.

HARRISON, M., M. G. PAYNE, G. W. MAAG, and R. J. HECKER. Some speculations on the role of dopamine in the resistance of sugarbeets to Cercospora leaf spot. J. Am. Soc. Sugar Beet Technol. 16(1):1970.

Experimental data of the authors and others show that dopamine, or oxidation products, are on the leaf surface and may inhibit spore germination of the pathogen. Both fungus infection and mechanical injury caused increased dopamine in the leaves. Under disease free conditions most resistant varieties have more dopamine in their leaves than do susceptible varieties. A number of phenolic compounds closely related to dopamine mediate the conversion of tryptophan to indolacetic acid (IAA). Dopamine inhibits IAA oxidase, increasing the IAA concentration, which in turn may initiate new meristematic activity to form a protective barrier around the infected area. Thus the mechanism of resistance to Cercospora beticola in sugarbeet seems to operate at two levels. In resistant varieties, entry and infection may be reduced and subsequent events may limit the activity of the pathogen after entry has been achieved.

HECKER, R. J., G. W. MAAG, and M. G. PAYNE. Inheritance of 3-hydroxytyramine in sugarbeet; a phenolic compound associated with Cercospora leaf spot resistance. J. Am. Soc. Sugar Beet Technol. 16(1):1970.

Anticipating that high 3-hydroxytyramine content may be of interest in breeding for increased leaf spot resistance, a study of its inheritance was conducted using a high and a low inbred and their F<sub>1</sub>, F<sub>2</sub>,

B<sub>1</sub>P<sub>1</sub>, and B<sub>1</sub>P<sub>2</sub> generations. Using the partitioning method of genetic analysis, genetic models involving different numbers of genes, varying additive gene effects, different degrees of dominance, epistasis, and linkage were tested in an attempt to explain the obtained F<sub>2</sub> and B<sub>1</sub> data. 3-hydroxytyramine content appeared to be conditioned by four or more genes with additive, partial dominance, and epistatic effects. If the inbred parents are typical of genotypes in the species, selection and breeding for increased 3-hydroxytyramine will likely be difficult due to multiple factors, dominance, and complex interactions.

HECKER, R. J., R. E. STAFFORD, R. H. HELMERICK, and G. W. MAAG. Comparison of the ~~sane~~ sugarbeet F<sub>1</sub> hybrids as diploids, triploids, and tetraploids. J. Am. Soc. Sugar Beet Technol. (In press).

Eight inbred lines were converted to autotetraploids. Twelve F<sub>1</sub> hybrids were made as diploids (2n), reciprocal triploids (3n), and tetraploids (4n). The F<sub>1</sub>'s were compared for one year at two field locations. The experiment indicated no general beneficial or detrimental effect on root yield or sucrose content from addition of one genome into F<sub>1</sub> genotypes. For root yield and sucrose content there were specific genotypes which responded favorably to the addition of a genome at a specific location. Most instances of triploid advantage occurred in those hybrids where the female parent was 4n. Genome addition was generally detrimental or immaterial to juice purity and impurity components. Any triploid advantage would likely be genotype specific and result from an increase in root yield and possibly sucrose. These specific genotypes would have to be identified in some type of combining test which would add greatly to the complexity of a triploid hybrid program.

HINE, R. B. and E. G. RUPPEL. Relationship of soil temperature and moisture to sugarbeet root rot caused by *Pythium aphanidermatum* in Arizona. Plant Disease Repr. 53: 989-991. 1969.

*Pythium aphanidermatum* caused a widespread and serious root rot of mature sugarbeets planted for the first time in the Bryce, Eden, Safford, and Thatcher areas of Graham County, Arizona. High incidence of the disease occurred during July and August, 1967 and 1968. Nearly 30% of a 1200-acre total crop was destroyed. Losses in individual fields ranged from 10 to 50%. Root rot occurred under environmental conditions of high soil temperature, excessive moisture and in heavy, poorly drained soils characterized by high soluble salt levels, high exchangeable sodium levels, and high soil pH. Although in Graham County the disease occurred primarily in fields with a long history of continuous cotton production, *P. aphanidermatum* was shown to be nonpathogenic to cotton in studies conducted in the field and in temperature-controlled growth chambers. The disease was also found in experimental plantings of sugarbeets at Marana, Arizona in 1967 and in commercial sugarbeet seed fields near Phoenix, Arizona in June 1969.



HOEFERT, LYNN L. Fine structure of sperm cells in pollen grains of Beta. Protoplasma 68: 237-240. 1969.

The structure of sperm cells in mature trinucleate pollen grains of Beta vulgaris L. was studied with the electron microscope. The ellipsoidal sperm cell nuclei and cytoplasm are products of mitosis and cytokinesis of the ellipsoidal generative cell. Each sperm cell is separated from the vegetative cytoplasm by two contiguous membranes which enclose its cytoplasm and nucleus. Microtubules present in the sperm cell cytoplasm may be responsible for sperm cell motility.

MAAG, G. W. Rapid digestion procedures for determination of metallic ions and total nitrogen in sugarbeet samples. J. Am. Soc. Sugar Beet Technol. 15: 361-367. 1969.

Chemical digestion of sugarbeet material is often a long, tedious process because the sugar causes excessive foaming. Good results have been obtained by using new, faster digestion procedures on thin juice and dried plant material. Discussion is limited to processing samples for atomic absorption spectrophotometric analysis for metallic ions and for total nitrogen determinations, including nitrate nitrogen. The digestion mixture for atomic absorption analysis is a combination of concentrated nitric, perchloric, and sulfuric acids. For total nitrogen, a mixture of concentrated sulfuric and perchloric acids plus salicylic acid is used. A small amount of sodium molybdate solution is added to each digestion mixture. The molybdate acts as a catalytic agent and does not interfere in the analysis. The amount of digestion mixture is adjusted to the kind and amount of sample used.

McFARLANE, J. S. Variety development. In Advances in Sugarbeet Production: Principles and Practices. Chapter 14. Iowa State University Press, Ames, Iowa. (In press).

This chapter discusses history, breeding methods, recent developments in breeding, cooperation in breeding research, and the future of sugarbeet breeding.

PAYNE, M. G., R. J. HECKER, and G. W. MAAG. Relation of certain amino acids to other impurity and quality characteristics of sugarbeet. J. Am. Soc. Sugar Beet Technol. 15(7):562-594. 1969.

Quantity of individual amino acids in thin juice and their relationship with yield and other quality characters was studied for 2 years on different genotypes at three nitrogen fertility levels. The most abundant amino acids were glutamic acid and aspartic acid. Quantity of all amino acids increased, with increased nitrogen fertilization, to a genotype dependent maximum or plateau. All the amino acids appeared to be quantitatively affected more by nitrogen fertility than



by genotype; genotype probably cannot overcome the detrimental effects of excess nitrogen. Betaine was conditioned more by genotype than nitrogen fertility. Quantities of copper, cobalt, calcium, magnesium, iron, and nickel in leaves at harvest were of little value in determining beet quality or sucrose yield.

RUPPEL, E. G. Comparisons of beet yellows virus isolates from Arizona. J. Am. Soc. Sugar Beet Technol. 16(1):1970.

Differences among five BYV isolates in host reaction to infection and, to a lesser extent, in ease of transmission by aphids or juice inoculation indicated that variant strains of the virus exist in Arizona. All isolates showed similarities to virulent strains of the virus from California; however, some differences were noted.

RUPPEL, E. G. Relationships of cucumber mosaic virus isolates from Arizona. Plant Disease Repr. (In press).

Isolates of cucumber mosaic virus (CMV) from sugarbeet, lettuce, and cantaloup in Arizona exhibited only minor variations in incubation period and disease severity within 14 selected hosts. Also, only minor differences in physical properties were noted among isolates. All isolates failed to infect a CMV-resistant cantaloup accession. The isolates mainly differed in their ability to multiply or maintain a comparable titre within tobacco source plants. The isolate from cantaloup, as measured by local lesion production in cowpea, was consistently more infectious than other isolates. In general, differences among the CMV isolates studied were considered of no practical importance to plant breeders.

RUSSELL, G. E. and JAMES E. DUFFUS. An aphid-transmitted yellowing disease of lettuce in England. Pl. Path. (In press).

During a survey of beet yellowing viruses in eastern England in August, 1968, leaves were collected from chlorotic lettuce (Lactuca sativa L.) plants in two fields near Potton, Bedfordshire. Most plants in these lettuce crops were stunted and their older leaves showed an intense interveinal yellowing. These symptoms closely resembled those caused by beet western yellows virus (BWYV) in lettuce in California. Accordingly, a series of transmission experiments was carried out under glass at the Plant Breeding Institute to determine if BWYV or a similar virus was responsible for the yellowing of lettuce at Potton. These confirmed the presence of a persistent, aphid-transmitted yellowing virus in lettuce crops in England. The identity of the causal virus is uncertain but its transmission characteristics, host range and symptomatology indicate that it is related to the group of yellowing viruses which comprises BWYV and beet mild yellowing virus (BMYV). Preliminary serological investigations indicate a relationship to BWYV, however, more complete data will have to be obtained to verify this relationship. This would be the first published record of BWYV outside the United States of America.

SCHNEIDER, C. L. A review of the Rhizoctonia crown and root rot disease of sugarbeet. Proc. 15th Regional Meeting Am. Soc. Sugar Beet Technol. pp. 27-28. 1969.

Symptomology, etiology and epidemiology are reviewed. Results of recent efforts to control the disease with resistant lines and with fungicides are presented.

SCHNEIDER, C. L. and H. S. POTTER. Results of field tests of fungicides to control sugarbeet diseases in 1968. Fungicide and Nematicide Tests--Results of 1968. Vol. 24: 76-78. 1969.

Among the 18 treatments tested for control of leafspot (Cercospora beticola), benomyl, TBZ, and triphenyl tin hydroxide were the most outstanding. None of the three seed treatments and 8 soil treatments tested for control of Rhizoctonia crown rot were efficacious. The best control of Aphanomyces seedling blight among 11 soil treatments tested, was obtained with Sodium-p-(dimethylamino) benzenediazo sulfonate (Dexon).

SEBESON, J. M., EARL MITCHELL, and F. W. SNYDER. Effect of phenolic acids on alpha-amylase in vitro, and early growth of sugarbeet. J. Am. Soc. Sugar Beet Technol. 15(7):556-561. 1969.

The effect of caffeic, ferulic, gallic, p-hydroxybenzoic, and vanillic acids on  $\alpha$ -amylase activity in vitro at molar concentrations of  $10^{-3}$  to  $10^{-6}$  was determined. Gallic acid was most inhibitory. Caffeic and p-hydroxybenzoic were intermediate, while ferulic and vanillic acids were least inhibitory in the range of  $10^{-3}$  to  $10^{-5}$ M. At  $10^{-4}$ M, they ranged between 37 and 89%; at  $10^{-5}$ M between 38 and 45%, and at  $10^{-6}$ M between 16 and 33%. Sugarbeet seeds, excised from the fruits, were placed in  $10^{-3}$  and  $10^{-4}$ M solutions of the five acids. Root growth after 5 days was measured. Root lengths tended to be shorter at  $10^{-3}$  than at  $10^{-4}$ M, but not statistically significant. The marked inhibition of the acids on  $\alpha$ -amylase activity in vitro does not occur in the intact seed during germination and subsequent growth.

SNYDER, F. W. and CHRISTINA FILBAN. Relation of sugarbeet seedling emergence to fruit size. J. Am. Soc. Sugar Beet Technol. 15(8):703-708. 1970.

Sugarbeet fruits were separated into large and small size-classes and placed on blotters for germination. Approximately 10 days after germination, 1-cm segments of hypocotyl were excised. The segments of hypocotyls from the large fruits weighed more than those from small fruits. The size differential could also be observed macroscopically. The percentage emergence of seedlings from moist quartz sand was determined when fruits were placed at 1/2- and 2-in. depths. As the fruits were planted deeper, fewer seedlings emerged. Significantly, at the 2-in. depth, proportionately fewer seedlings emerged from the



small fruits than from the large when compared to the 1/2-in. depth. The trends in emergence potential obtained in sand in the laboratory were confirmed by emergence from soil under field conditions. The results indicate that seeds in large sugarbeet fruits have a greater emergence force and emergence potential than seeds in small fruits.

STEELE, A. E. and J. M. FIFE. Effect of liquid nutrient culture, vacuum distillation and dialysis on hatching activity of sugarbeet root diffusate for *Heterodera schachtii*. J. Nematology 1: 223-226. 1969.

Roots of sugarbeets grown in liquid culture excrete substances that stimulate egg hatch and emergence of larvae from cysts of *Heterodera schachtii*. Their hatching effect is comparable to that of sugarbeet root diffusate leached from soil-grown sugarbeet plants. Consequently, liquid culture provides a way of obtaining *H. schachtii* hatch-stimulant free of contaminants from soil. Root diffusate, concentrated 50-fold or dried by vacuum distillation, retain hatching activity. The active principle of diffusate is dialyzable with a diffusion rate between those of inorganic salts and compounds with molecular weights greater than 15,000.

STORER, K. R., W. R. SCHMEHL, and R. J. HECKER. Quantitative growth studies with sugarbeets, *Beta vulgaris*. J. Am. Soc. Sugar Beet Technol. 15(8):709-725. 1970.

Two sugarbeet varieties and five nitrogen treatments were used in a field experiment to study the effect of variations in leaf canopies on root and sucrose yield. There were varietal differences for leaf area, root yield, and sucrose yield, the latter resulting from late season root yield differences. Higher rates of nitrogen applied preplant in March resulted in greater leaf canopies early in the season and caused greater final sucrose yields. These greater sucrose yields were a consequence of larger root yields with only small reductions in sugar content. July applied nitrogen resulted in a large late canopy but root yields did not increase proportionate to leaf area, and sugar content decreased appreciably, resulting in reduced sugar yields. Optimum leaf area index for sugar production appeared to be 3 to 4. Highest sugar accumulation rates during the season shifted among certain nitrogen treatments depending on both leaf area and nitrogen status of the plant.

THEIS, THOMAS. Sugarbeet as a crop. In Advances in Sugarbeet Production: Principles and Practices. Chapter 1. Iowa State University Press, Ames, Iowa. (In press).

This is an introductory chapter in a book dealing with sugarbeet production.



THEURER, J. C. and G. K. RYSER. Double-cross sugarbeet hybrids utilizing pollen restorers. Crop Sci. 9(5): 610-612. 1969.

Experimental studies in 1965 and 1966 indicated that double-cross restored hybrid sugarbeets have excellent potential for commercial use. In isolated seed plots, the female parental single crosses averaged about 100 gms of double-cross seed per plant. Forty-six experimental double crosses showed favorable performance for gross sugar, root yield, sugar percentage, and quality in relation to that of two currently used commercial cultivars. A method for production of the double-cross hybrid seed on a commercial scale is outlined.

THEURER, J. C. and G. K. RYSER. Inheritance studies with a pollen restorer sugarbeet inbred. J. Am. Soc. Sugar Beet Technol. 15(6): 538-545. 1969.

An inbred sugarbeet line carrying strong pollen-restorer genes has been isolated from the variety US 201. Studies of inheritance tend to confirm Owen's original premise that CMS is governed by complementary genetic factors. However, interaction between modifying genes and cytoplasm, and the influence of environment resulted in poor fits to classical genetic ratios. NB-1 CMS tended to resist fertility restoration more than 18 other CMS lines studied.

THEURER, J. C., G. K. RYSER, and MYRON STOUT. A comparison of genic male-sterile and cytoplasmic male-sterile four-way sugarbeet hybrids. Crop Sci. 9(6): 741-743. 1969.

In 1966 and 1967 comparison was made of 12 four-way sugarbeet hybrids having a cytoplasmic male sterile X pollen restorer male parent, and an equivalent number of hybrids of the same parental lines having a genic male sterile X pollen restorer parent. The genic male sterile X pollinator crosses had a higher sugar percentage and a lower impurity index than cytoplasmic male sterile X pollinator hybrids. Yield of gross sugar and tonnage were similar for the two males averaged over all crosses. The performance of specific male and female parents indicates that good combining ability between cytoplasmic male sterile X restorer pollinators may not necessarily show how equivalent genic male sterile X pollinator crosses will behave.

WHITNEY, E. D. and D. L. DONEY. Large scale hatching, disinfestation and storage of Heterodera schachtii larvae. Phytopathology (In press).

Methods of hatching, disinfesting and storing large numbers of second stage Heterodera schachtii larvae without loss of infectivity are described. For greenhouse studies larvae are hatched by incubating screened cysts for 3-5 days in 4 mM zinc chloride, 10 ppm ethoxyethyl mercury chloride, 0.01% dioctyl sodium sulphosuccinate, 1 mg/ml streptomycin sulfate and 1000 units/ml penicillin G potassium. The larvae

are further treated in the same solution for 72 hr to reduce contamination. For pure culture studies the larvae are hatched by incubating recently matured hand-picked cysts as described for greenhouse studies. The larvae are further disinfested, however, by placing them in the above solution plus neomycin sulfate (1 mg/ml) for 7 days. Surface disinfestation of the larvae was complete after storage at 24 C for 30 days as indicated on a wide range of media. Infectivity of the larvae was determined by staining and counting the number of larvae infecting 3-week-old sugarbeet seedlings grown in sand culture.

ZINK, F. W. and JAMES E. DUFFUS. Linkage of turnip mosaic virus susceptibility and downy mildew (*Bremia lactucae*) resistance in lettuce. J. Am. Soc. Hort. Sci. (In press).

Data for resistance in *Lactuca sativa* L. to turnip mosaic virus (TuMV) and downy mildew were obtained from 8 F<sub>2</sub> progenies of crosses between TuMV-susceptible, mildew-resistant, and TuMV-resistant, mildew-susceptible parents. The F<sub>1</sub> progeny were TuMV and mildew resistant. Of 3,682 F<sub>2</sub> plants assayed 2,773 were TuMV resistant and 909 TuMV susceptible. A total of 2,788 mildew-resistant plants were observed, and 904 mildew susceptible. Resistance to TuMV and mildew are each controlled by a single dominant gene, designated herein as Tu and Dm. The TuMV-susceptible gene, tu, is linked with the mildew-resistant gene, Dm. In the repulsion phase, the cross-over value was 12.5% + 1.6.

ZINK, F. W. and JAMES E. DUFFUS. Relationship of turnip mosaic virus susceptibility and downy mildew (*Bremia lactucae*) resistance in lettuce. J. Am. Soc. Hort. Sci. 94: 403-407. 1969.

A mosaic disease of *Lactuca sativa* L. is described and the causal agent identified as turnip mosaic virus (TuMV). Extensive infection reduces the yield appreciably or may destroy entirely the value of the crop. A survey of *L. sativa* cultivars indicated that TuMV susceptibility is restricted to mildew resistant: crisphead types: 'Calmar', 'E-4', 'Imperial 410', 'Imperial Triumph', 'Valrio', 'Valtemp', and 'Valverde'. Circumstantial evidence indicates that TuMV susceptibility in cv. 'Calmar', 'Imperial 410', 'Valrio', 'Valtemp', and 'Valverde' stems from the mildew resistant *L. serriola* L. (P.I. 91532). TuMV and mildew resistant cultivars are: butterhead type 'May King', 'Meikoningin', 'Proeftuin's Blackpool', 'Ventura'; leaf type 'Red Salad Bowl', 'Salad Trim'; cos type 'Valmaine'. Seed collections of *L. serriola* from the Santa Clara and Salinas Valleys of California produced plants that fell into 3 classifications: a) TuMV-resistant, mildew-resistant; b) TuMV-resistant, mildew-susceptible, and c) TuMV-susceptible, mildew-resistant. No plants in *L. sativa* or *L. serriola* were susceptible to both TuMV and mildew. Extreme resistance to TuMV was demonstrated in *L. sativa* and *L. serriola*. TuMV-susceptible *L. sativa* cultivars showed differences in tolerance to symptom expression and resistance to infection. In *L. serriola* a resistance connected with a hypersensitivity reaction was observed.





## SUGARBEET RESEARCH

1969 Report

### Section B

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## DEVELOPMENT OF BREEDING LINES AND VARIETIES FOR CALIFORNIA

I. O. Skoyen, R. T. Lewellen, J. S. McFarlane, and K. D. Beatty

### Summary of Accomplishments, 1969

The development of breeding lines and varieties adapted to California is supported in part by Foundation projects 12, 24, and 29. The California Beet Growers Association supports the testing program in the Imperial Valley and yellows resistance breeding work at Salinas. This past year much of the work at Salinas was done by Mr. I. O. Skoyen and Dr. R. T. Lewellen. Dr. J. S. McFarlane was appointed Leader of Sugarbeet Investigations and was assigned to the Beltsville, Maryland office for ten months. Emphasis continued to be placed on the development of breeding lines and varieties combining resistance to bolting and disease. A portion of the variety evaluation was done in cooperative tests by the four California sugar companies.

BOLTING RESISTANCE--The 1968-69 growing season favored the induction of bolting in the coastal valleys of California. At Salinas, low temperatures persisted throughout the summer and bolting induction continued until harvest. Bolting occurred in nearly all lines in a November 14, 1968, planting and increased as the season progressed.

Among a group of 22 three-way hybrids (page B22), bolting ranged from 9.4% for 813H8 to 34.1% for 813H48. The US H9 hybrids bolted 20% and US H7 22% in this test. Holly Sugar Corporation determined the bolting resistance of a similar group of hybrids in an October 8 planting at Tracy (page B45). In this test 813H8 bolted 5% and 813H48 bolted 39%. US H9A bolted 12% at Tracy compared with 19% bolters for US H7. The results of the Salinas and Tracy tests indicated that 813, the most recent yellows resistant selection from US 75, is superior to 413 in bolting resistance. Increases of 413 are currently being used as the pollen parent in the US H9 hybrids.

The multigerm inbred NB6 again proved outstanding in bolting resistance. No bolters were observed in this line at either Salinas or Tracy. The monogerm inbreds 563 and 564 also showed good resistance. FC601, an inbred line developed at Fort Collins, bolted only 1.7% in the Salinas November test. Mildew was severe in FC601 and may have influenced the bolting. Bolting averaged only 1% to 2% in a January 9-10 planting at Salinas. In the Imperial Valley bolting among commercial varieties was also low.

Bolting percentages for a representative group of hybrid varieties and pollinator lines follow:

		Salinas	Tracy	Brawley
US H7	(562H0 x 569) x 264	22.0	19	0.5
US H9A	(562H0 x 569) x 413	20.0	12	1.0
US H9B	(562H0 x 546) x 413	20.1	17	2.5
813H8	(562H0 x 546) x 813	9.4	5	0.4
Y804H8	(562H0 x 546) x Y804	16.8	32	3.0
F68-413	Inc. 413	23.8	15	10.2
F68-613	7th YRS US 75	27.0	17	14.6
813	8th YRS, 2nd SS US 75	13.5	--	4.0
Y804	Inc. (513 x 234)	26.5	--	19.6

YELLOW S RESISTANCE --The self-sterile selection 813 showed promise in the 1969 tests. 813 is the increase of the sixth yellows resistant selection plus two yellows resistant and sucrose selections from US 75. This line showed increased yellows resistance and higher sucrose percentage than its sister selection, F68-413. Three-way hybrids with 813 as the top-cross parent also showed greater yellows resistance than similar hybrids produced with F68-413. Additional hybrid seed was produced in 1969 and 813 hybrids will be extensively tested in 1970.

Continued emphasis ~~was~~ placed on the development of yellows resistant monogerm inbreds and their male-sterile equivalents. In a test of self-fertile lines at Salinas, 705 continued to be the most resistant monogerm inbred. It also showed good combining ability when used ~~as~~ a component in three-way hybrids, e.g., 13H50.

Four F1 hybrids utilizing the best yellows resistant inbreds and six self-sterile lines were evaluated at Davis for their specific resistance to BYV or BWYV. In general, the lines with the best BYV resistance also had the best BWYV resistance, and damage caused by BWYV was about one half of that caused by BYV.

Beet mosaic virus is often associated with the virus yellows complex. The inheritance of a potential source of resistance ~~was~~ investigated in 1969.

DOWNY MILDEW RESISTANCE--For the first time in more than ten years moderately severe downy mildew infection occurred in the Salinas field tests. Several susceptible lines from Colorado were included in the November planting. Mildew infection was first observed in these lines and gradually spread throughout the test area. Three months of cool, rainy weather favored disease development and by mid-June over 50% infection occurred in the most susceptible lines. The disease incidence



decreased as the distances from the infection centers increased. Infection was more severe in the January planting than in the November planting. Among 22 hybrids included in both plantings, infection averaged 13.5% to 22% for the January planting compared with 2% to 10.5% for the November planting. Little to no infection was observed in commercial fields in the Salinas area.

Commercial varieties and the hybrid components of these varieties showed moderate resistance. Infection occurred mainly as localized infections on leaf blades or involved the new leaves near the crown. Only occasionally did infection of the entire crown area occur. Mildew percentages for a group of hybrid varieties, pollinator lines, seed bearing parents, and inbred parents follow:

	<u>November Planted</u>	<u>January Planted</u>		<u>November Planted</u>
<u>Hybrids</u>			<u>Seed Bearing Parents</u>	
US H7	10	20	F67-569H3	6
US H7A	11	22	F68-546H3	3
US H9A	6	17	F68-546H4	2
US H9B	7	17	F68-546H5	4
US H6	8	--		
<u>Pollinator Lines</u>			<u>Inbred Lines</u>	
US 75	13	22	F66-562H0	6
F68-413	15	31	F67-563H0	2
F68-613	6	29	F67-564H0	7
813	7	24	F66-550	11
F66-64	--	32	F66-569	11
			8502 (NB1)	20
			F60-512 (NB6)	62

Although moderate resistance to mildew has generally been maintained in the Salinas breeding program, occasionally recent selections or new hybrid combinations averaged up to 37 percent infection in the November planting. This occurred most frequently in virus yellows resistant selections but also included recent curly top selections.

The mildew incidence in 1969 demonstrates that the potential for economic loss still exists in coastal areas. Breeders must strive to maintain at present levels the moderate resistance which has effectively limited mildew damage to sugarbeets since the mid-1950s.

POLYPLOIDY--Triploid hybrids that used the 713T line as the pollinator were evaluated in several variety tests throughout the state. The results of these tests are summarized on pages B10 and B11. Most of these hybrids utilized yellows resistant seed-bearing parents in addition to the

yellow resistant tetraploid pollinator. The performance of these triploids tended to be superior at Salinas in tests with moderate to severe yellows infection. Performance ~~was~~ frequently no better or slightly inferior to that of US H9 in Imperial Valley and Central Valley tests.

Comparisons were also made between comparable diploid and triploid hybrids in tests at Salinas and Brawley. The Salinas test ~~was~~ planted January 9 and harvested October 1. Two Brawley tests were planted September 9, 1968. One test was harvested April 22 and the second June 11, 1969. The performance of four diploid hybrids and of their triploid counterparts follows:

<u>Variety</u>	<u>Diploid</u>		<u>Triploid</u>	
	<u>T/A</u>	<u>% Sucrose</u>	<u>T/A</u>	<u>% Sucrose</u>
813H8				
Salinas	44.00	16.3	45.76	16.4
Brawley (EH)	24.92	13.2	25.38	12.6
Brawley (LH)	32.19	15.3	32.21	15.5
813H32				
Salinas	46.58	15.7	47.09	15.8
Brawley (EH)	24.60	12.5	23.62	12.4
Brawley (LH)	31.93	14.3	31.05	14.3
813H41				
Salinas	45.00	16.6	45.85	15.9
Brawley (EH)	25.15	12.5	24.59	12.5
Brawley (LH)	31.00	14.6	32.64	14.5
813H49				
Salinas	46.47	16.3	45.72	16.6
Brawley (EH)	24.87	13.2	25.54	12.8
Brawley (LH)	31.17	15.0	32.06	15.2

These tests failed to show consistent superiority for the triploids. In some tests, the triploid form of a hybrid tended to be slightly superior, whereas in others the diploid form showed the best performance. Rarely were differences in performance between diploid and triploid hybrids significant. These results are in agreement with those obtained in previous years.

Performance of US H9A and US H9B expressed in percent of the performance of the standard US H7 variety in tests exposed to varying amounts of virus yellows.

Location	No. Tests	Year	Gross Sugar Yield		Percent Sucrose	
			US H9A	US H9B	US H9A	US H9B
<u>Severe yellows</u>						
Salinas Valley	1	1965	116	115	97	103
Salinas Valley	2	1966	126	136	102	103
Sacramento Valley	1	1966	134	136	102	104
Salinas Valley	1	1967	120	122	102	105
Salinas Valley	1	1968	113	113	98	99
Sacramento Valley	1	1968	119	129	104	102
Salinas Valley	1	1969	123	131	100	104
Sacramento Valley	1	1969	100	104	98	97
Imperial Valley	3	1969	116	119	102	103
Average			119	123	101	102
<u>Moderate yellows</u>						
Salinas Valley	2	1966	122	118	104	104
Imperial Valley	2	1966	129	141	102	103
Salinas Valley	1	1967	107	--	95	--
Salinas Valley	1	1967	111	110	102	99
Imperial Valley	1	1967	123	124	101	99
Imperial Valley	5	1967	123	--	104	--
Imperial Valley	2	1968	115	117	99	98
Salinas Valley	5	1969	121	113	96	96
Imperial Valley	5	1969	123	127	102	103
Average			121	121	101	100
<u>Light yellows</u>						
Salinas Valley	2	1965	120	--	103	--
Imperial Valley	1	1965	117	--	101	--
Sacramento Valley	1	1966	111	107	101	98
Salinas Valley	3	1967	112	--	100	--
Imperial Valley	2	1967	118	--	102	--
San Joaquin Valley	1	1967	112	--	105	--
Salinas Valley	3	1968	110	110	98	96
Salinas Valley	5	1968	--	108	--	99
Imperial Valley	4	1968	106	107	101	101
Sacramento Valley	1	1968	114	--	98	--
Sacramento Valley	1	1968	103	109	99	97
San Joaquin Valley	1	1968	--	104	--	103
San Joaquin Valley	4	1968	112	111	102	100
Salinas Valley	1	1969	103	104	95	98
Sacramento Valley	2	1969	100	108	98	100
San Joaquin Valley	1	1969	121	102	99	94
Average			111	108	100	99





SUMMARY.--Sucrose percentage of diploid hybrids in 1969  
California variety tests, expressed in percent of US H9B.

Location	Testing Agency	US H9B	US H9A	US H7	US H7A	613H4	713H4	13H8	13H11	13H42	13H44	13H45	13H46	13H48	13H50	Y804H8
<u>Coastal Area</u>																
Salinas - Nov. plt.	USDA	100	100	100	104	101	101	103	-	102	103	101	102	99	105	102
Salinas - Jan. plt.	"	100	97	102	101	97	101	99	97	100	104	102	98	99	100	99
Salinas (yel. inoc.)	"	100	96	96	-	97	99	102	97	99	99	99	100	97	100	97
Salinas	Union	100	98	102	104	-	-	100	96	100	101	100	100	-	102	-
<u>Central Valley</u>																
Mendota	Spreckels	100	106	106	104	-	103	106	-	-	-	108	-	-	106	-
Woodland	"	100	95	97	-	-	98	-	-	-	-	-	-	-	-	-
Tulare - Fall	Holly	100	103	100	-	-	-	94	97	101	-	104	-	-	105	-
Tulare - Winter	"	100	95	96	-	-	-	102	-	97	-	102	-	-	98	-
Tracy - Fall	"	100	100	-	-	-	-	100	-	93	-	107	-	-	98	-
Clarksburg - Spring	Am. Crystal	100	101	102	-	101	-	-	98	-	-	-	-	-	-	-
Clarksburg - Fall	"	100	104	106	-	-	-	106	99	-	107	103	-	-	109	-
Davis	USDA	100	101	104	-	101	102	98	98	103	103	-	99	99	101	97
Davis (yel. inoc.)	"	100	102	100	-	108	104	103	99	106	106	-	103	101	105	100
<u>Imperial Valley</u>																
Brawley - 1st har.	"	100	98	98	100	98	101	103	-	100	100	102	101	98	104	100
Brawley - 2nd har.	"	100	99	97	-	-	-	99	-	-	95	98	98	-	99	98
Brawley - 3rd har.	"	100	100	96	97	-	-	99	-	-	-	-	-	-	-	-
Imp. Valley - Early	Holly	100	98	101	101	-	-	99	100	100	-	100	-	-	-	-
Imp. Valley - 1st har.	"	100	98	101	-	-	-	-	99	-	-	-	-	-	104	-
Imp. Valley - 2nd har.	"	100	102	98	-	-	-	-	99	-	-	-	-	-	106	-
Imp. Valley - 3rd har.	"	100	103	97	-	-	-	-	98	-	-	-	-	-	103	-
Calipatria	Union	100	98	97	-	-	-	-	-	-	-	-	-	-	100	-
El Centro	"	100	99	95	-	-	-	-	-	-	-	-	-	-	100	-

613H4---(562H0 x 569) x 513  
 713H4---(562H0 x 569) x 613A  
 13H8---(562H0 x 546) x 713A  
 13H11---(563H0 x 550) x 413  
 13H42---(754H4 x 704) x 713A  
 13H44---(705H24 x 714) x 713A  
 13H45---(705H25 x 718) x 713A  
 13H46---(716H29 x 718) x 713A  
 13H48---(716H29 x 734) x 713A  
 13H50---(705H24 x 705) x 713A  
 Y804H8---(562H0 x 546) x Y704

SUMMARY.--Gross sugar yields of triploid hybrids in 1969 variety tests, expressed in percent of yield of US H9B.

Location	Testing Agency	US H9B	13TH8	13TH32	13TH40	13TH41	13TH49
Salinas (Nov. plt.)	UEIDA	100	-	107	103	104	101
Salinas (Jan. plt.)	"	100	104	104	105	101	105
Salinas (yel. inoc.)	"	100	-	110	108	114	109
Salinas	Union	100	-	104	108	103	-
Mendota	Spreckels	100	-	95	-	90	-
Tracy (Fall)	Holly	100	-	85	-	83	90
Tulare (Fall)	"	100	-	120	-	103	109
Davis	USDA	100	-	-	99	-	102
Davis (yel. inoc.)	"	100	-	-	104	-	121
Brawley - 1st har.	"	100	98	90	-	93	100
Brawley - 2nd har.	"	100	101	90	-	96	99
Brawley - 3rd har.	"	100	106	-	-	-	-
El Centro	Union	100	-	-	-	-	105
Calipatria	"	100	-	-	-	-	118
Imp. Valley (Early)	Holly	100	-	95	-	87	90
Clarksburg	Am. Crystal	100	-	89	106	90	-
Drayton, No. Dakota	"	100	-	95	98	91	-

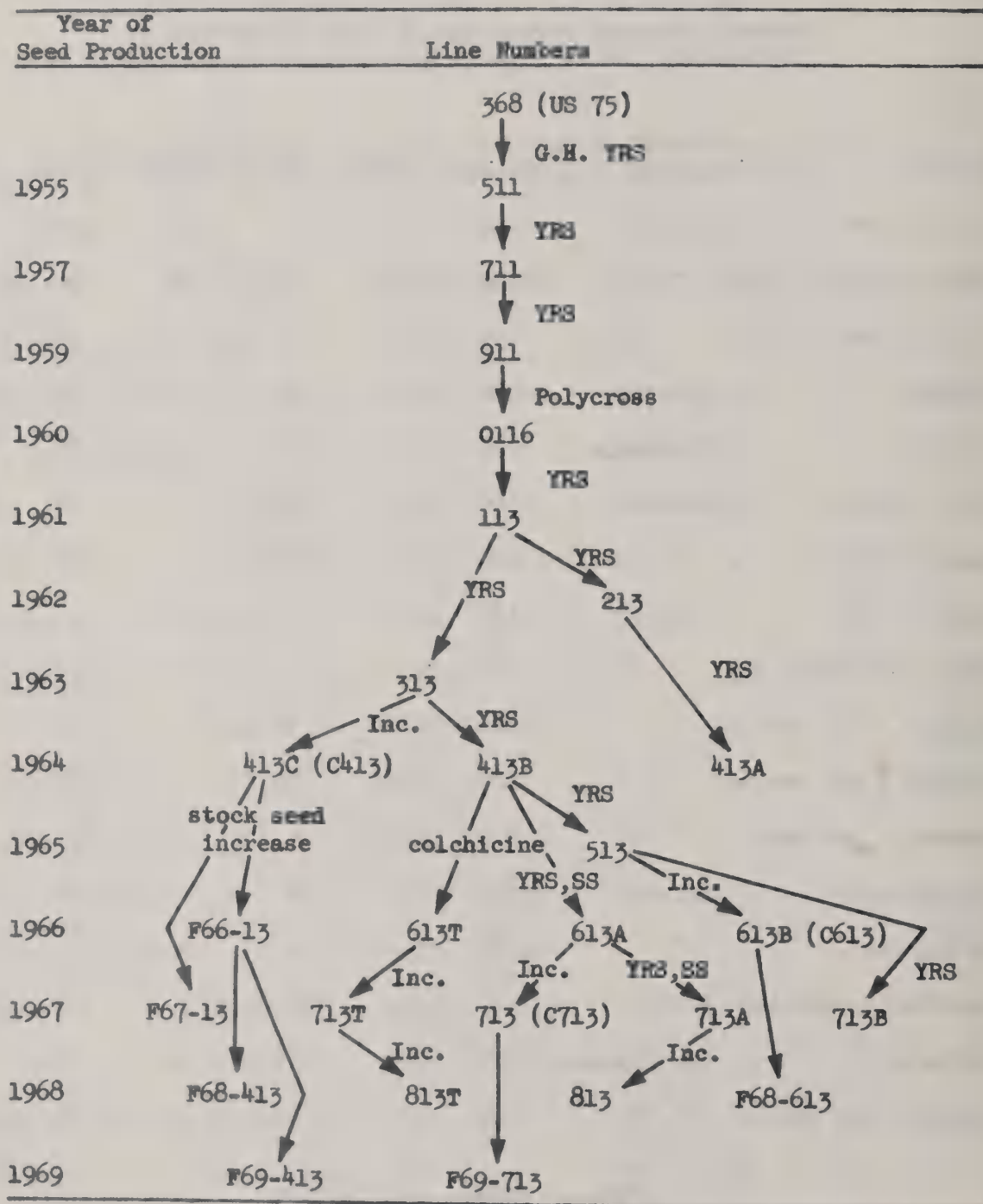


SUMMARY.--Sucrose percentage of triploid hybrids in  
1969 variety tests, expressed in percent of US H9B.

Location	Testing Agency	US H9B	13TH8	13TH32	13TH40	13TH41	13TH49
Salinas (Nov. plt.)	USDA	100	-	93	101	100	100
Salinas (Jan. plt.)	"	100	101	97	99	98	102
Salinas (yel. inoc.)	"	100	-	95	94	97	97
Salinas	Union	100	-	96	99	98	-
Mendota	Spreckels	100	-	97	-	96	-
Tracy (Fall)	Holly	100	-	92	-	96	94
Tulare (Fall)	"	100	-	98	-	99	102
Davis	USDA	100	-	-	94	-	96
Davis (yel. inoc.)	"	100	-	-	98	-	103
Brawley - 1st har.	"	100	95	94	-	95	97
Brawley - 2nd har.	"	100	101	93	-	95	99
Brawley - 3rd har.	"	100	99	-	-	-	-
El Centro	Union	100	-	-	-	-	100
Calipatria	"	100	-	-	-	-	104
Imp. Valley (Early)	Holly	100	-	100	-	100	101
Clarksburg	Am. Crystal	100	-	93	91	94	-
Drayton, No. Dakota	"	100	-	98	97	98	-

13TH8----(562H0 x 546) x 713T  
 13TH32---(754H0 x 716) x 713T  
 13TH40---(754H0 x 760) x 713T  
 13TH41---(716H29 x 757) x 713T  
 13TH49---(716H0 x 760) x 713T

Year of production and pedigree of the yellows resistant selection 13 developed by J. S. McFarlane and I. O. Skoyen at Salinas, California.



YRS - Yellows resistant selection based on freedom from yellows, stunting, necrosis, and root size.

YRS, SS - Same as YRS but with selection for sucrose percent.

Inc. - Seed increase either in a greenhouse or field isolation.

VARIETY TESTS, BRAWLEY, CALIFORNIA, 1968-69

Location: U.S. Department of Agriculture, Southwestern Irrigation Field Station.<sup>1/</sup>

Soil type: Holtville silty clay loam.

Previous crops: Barley, 1964-68.

Fertilizer used: Thirty-six lbs. per acre phosphorus, actual, and 20 lbs. per acre nitrogen broadcast preplant before listing. 175 lbs. per acre nitrogen sidedressed October 14, 1968.

Herbicide used: Four lbs. per acre Roneet ~~was~~ bed-incorporated in a 10" band to a maximum depth of 3 inches.

Planting date: September 9, 1968.

Thinning dates: October 2-4 and 14, 1968.

Harvest dates: Early harvest, April 21-24, 1969.  
Intermediate harvest, June 10-11, 1969.  
Late harvest, July 14, 1969.

Irrigations: Early harvest, 8 irrigations plus 1.20 inches rainfall.  
Intermediate harvest, 10 irrigations plus 1.20 inches rainfall.  
Late harvest, 13 irrigations plus 1.20 inches rainfall.

Diseases and insects: The earliest symptoms of virus yellows infection occurred in late November. A severe infection ~~was~~ evident by early January. Curly top ~~was~~ of minor importance in the test plots. Two spray applications of Ethyl parathion were used at rates of 12 and 16 oz. per ~~acre~~ to control desert flea beetle, striped cucumber beetle and crickets. Army ~~worm~~ and looper ~~worm~~ were controlled with three applications of Methyl parathion at rates of 12-15 oz. per acre, and with ~~one~~ pound of DDT per acre. Fifteen pounds per acre of 10% Thimet granules were applied in early February to control green peach aphid and leafhoppers. Three percent Kelthane ~~was~~ applied at a rate of 40 gallons per ~~acre~~ on April 30 to control red spider mites in the intermediate and late ~~season~~ harvested tests.

Experimental design: All yield tests ~~were~~ of randomized block design except test 6, which ~~was~~ a 10 x 10 latin square. Tests 1, 2, and 3 ~~were~~ planted for early ~~season~~ harvest, tests 4, 5, and 6 for intermediate harvest, and test 7 for late season harvest. All plot ~~rows~~ were 45 feet long. Rows spaced 30 inches apart.

Sugar analysis: From two ten-beet samples per plot for all tests by Holly Sugar Corporation, Brawley, California.

Remarks: Test designed and results analyzed by the United States Agricultural Research Station, Salinas, California.

<sup>1/</sup> Plot under supervision of K. D. Beatty, stationed at the Southwestern Irrigation Field Station, Brawley, California.



VARIETY TEST, BRAWLEY, CALIFORNIA, 1969

(10 replications of each variety)  
(Two-row plots)

Planted: September 9, 1968  
Harvested: April 21, 1969

Test 1

Variety	Description	Acre Yield		Sucrose Percent	Bolting Percent	Harvest Count Number
		Sugar Pounds	Beets Tons			
813H46	(716H29 x 718) x 713A	7,080	25.64	13.8	0.0	118
813H45	(705H25 x 718) x 713A	7,010	25.15	14.0	0.0	106
813H44	(705H24 x 714) x 713A	6,920	25.25	13.7	0.0	95
813H42	(754H4 x 704) x 713A	6,740	24.68	13.7	0.1	113
813H8	(562H0 x 546) x 713A	6,700	23.74	14.1	0.0	121
713H4	(562H0 x 569) x 613A	6,700	24.37	13.8	0.0	124
613H4	(562H0 x 569) x 513	6,660	24.86	13.4	0.0	124
813H48	(716H29 x 734) x 713A	6,650	24.83	13.4	0.6	117
813H50	(705H24 x 705) x 713A	6,590	23.05	14.3	0.1	120
813H47	(705H25 x 751) x 713A	6,520	22.70	14.4	0.0	115
U713H8	US H9B	6,440	23.48	13.7	0.2	126
Y803H4	(562H0 x 569) x Y603	6,380	22.22	14.4	0.1	111
U713H4	US H9A	6,330	23.74	13.4	0.1	130
Y804H8	(562H0 x 546) x Y704	6,280	23.09	13.7	0.1	114
4539H4	US H8	5,880	20.92	14.1	0.0	124
664H8	US H7A	5,790	21.09	13.7	0.0	118
664H4	US H7	5,700	21.27	13.4	0.0	124
868H4	(562H0 x 569) x 868	5,170	18.72	13.8	0.0	121

General MEAN of all varieties	6,420	23.27	13.8	0.1	Beets per 100'
Significant Difference (19:1)	322	1.13	0.53	0.24	
Coefficient of Variation (%)	5.69	5.49	4.33	385.95	
Calculated F value	18.74**	21.00**	3.09**	3.14**	row

\*\*Exceeds the 1% point of significance (F=2.11)

VARIETY TEST, BRAWLEY, CALIFORNIA, 1969

(10 replications of each variety)  
(Two-row plots)

Planted: September 9, 1968

Harvested: April 22, 1969

Test 2

Variety	Description	Acre Yield		Sucrose Percent	Bolting Percent	Harvest Count Number
		Sugar Pounds	Beets Tons			
813H8A	(562H0 x 546) x F66-13	6,540	24.92	13.2	0.2	102
813H49A	(716H0 x 760) x F66-13	6,540	24.87	13.2	0.3	117
813TH49	(716H0 x 760) x 713T	6,540	25.54	12.8	0.6	99
813TH8	(562H0 x 546) x 713T	6,410	25.38	12.6	0.2	87
813H41A	(716H29 x 757) x F66-13	6,250	25.15	12.5	0.4	115
813H32A	(754H0 x 716) x F66-13	6,120	24.60	12.5	0.0	104
813TH41	(716H29 x 757) x 713T	6,110	24.59	12.5	0.0	106
813TH32	(754H0 x 716) x 713T	5,860	23.62	12.4	0.2	102
General MEAN of all varieties		6,300	24.83	12.7	0.2	Beets
Significant Difference (19:1)		354	NS	0.45	NS	per
Coefficient of Variation (%)		6.28	5.46	3.94	251.09	100'
Calculated F value		4.12**	NS	4.02**	NS	row

\*\*Exceeds the 1% point of significance (F=2.94)

VARIETY TEST, BRAWLEY, CALIFORNIA, 1969

(10 replications of each variety)  
(One-row plots)

Planted: September 9, 1968  
Harvested: April 23, 1969

Test 3

Variety	Description	Acre Yield		Sucrose Percent	Bolting Percent	Harvest Count Number
		Sugar Pounds	Beets Tons			
544	Increase (330 x 234)	6,870	26.55	13.0	0.0	116
Y804	Inc. (YRS 534 x YRS 413)	6,620	26.18	12.7	3.0	112
F68-(6) 13	Increase 613	6,330	25.79	12.3	1.8	120
F67-13	Increase 413	6,050	25.35	12.0	2.5	121
713	7 YRS, 1 Suc. Sel. US 75	6,020	25.06	12.1	1.1	123
Y803	Increase YRS 534	6,010	20.73	14.5	0.0	101
F68-(4) 13	Increase F66-13	6,000	25.40	11.9	2.1	128
813	8 YRS, 2 Suc. Sel. US 75	5,990	22.90	13.1	1.0	118
F66-13	Increase 413	5,770	23.94	12.2	1.2	124
813T	Increase 713T	5,410	22.90	11.9	1.1	96
730T	Increase 630T	4,750	21.19	11.2	0.0	109
868	Increase F57-68 (US 75)	4,630	19.11	12.1	0.0	119
General MEAN of all varieties		5,870	23.76	12.4	1.2	Beets
Significant Difference (19:1)		532	2.13	0.42	1.2	per
Coefficient of Variation (%)		10.24	10.13	3.78	120.30	100'
Calculated F value		12.27**	9.97**	32.51**	5.60**	row

\*\*Exceeds the 1% point of significance (F=2.43)



VARIETY TEST, BRAWLEY, CALIFORNIA, 1969

(10 replications of each variety)  
(Two-row plots)

Planted: September 9, 1968  
Harvested: June 10, 1969

Test 4

Variety	Description	Acre Yield		Sucrose Percent	Bolting Percent	Harvest Count Number
		Sugar Pounds	Beets Tons			
813H46	(716H29 x 718) x 713A	10,680	31.85	16.8	0.3	118
U713H8	US H9B	10,500	30.89	17.1	2.5	120
813H45	(705H25 x 718) x 713A	10,490	31.34	16.7	1.0	118
813H8	(562H0 x 546) x 713A	10,260	30.24	17.0	0.4	130
4539H4	US H8	10,180	30.51	16.7	0.3	130
U713H4	US H9A	10,000	29.54	17.0	1.0	139
813H44	(705H24 x 714) x 713A	9,970	30.74	16.3	2.9	103
Y804H8	(562H0 x 546) x Y704	9,810	29.37	16.8	3.0	119
Y803H4	(562H0 x 569) x Y603	9,730	28.81	17.0	0.3	124
813H50	(705H24 x 705) x 713A	9,720	28.85	16.9	2.5	121
813H47	(705H25 x 751) x 713A	9,470	28.37	16.7	0.4	117
664H4	US H7	8,370	25.24	16.6	0.5	126
General MEAN of all varieties		9,930	29.65	16.8	1.3	Beets
Significant Difference (19:1)		646	2.06	NS	1.09	per
Coefficient of Variation (%)		7.35	7.85	6.32	97.45	100'
Calculated F value		7.02**	5.72**	NS	8.16**	row

\*\*Exceeds the 1% point of significance (F=2.43)

VARIETY TEST, BRAWLEY, CALIFORNIA, 1969

(10 replications of each variety)  
(Two-row plots)

Planted: September 9, 1968  
Harvested: June 11, 1969

Test 5

Variety	Description	Acre Yield		Sucrose Percent	Bolting Percent	Harvest Count Number
		Sugar Pounds	Beets Tons			
813TH8	(562H0 x 546) x 713T	9,970	32.21	15.5	2.5	100
813H8A	(562H0 x 546) x F66-13	9,860	32.19	15.3	4.4	103
813TH49	(716H0 x 760) x 713T	9,750	32.06	15.2	6.0	111
813TH41	(716H29 x 757) x 713T	9,460	32.64	14.5	4.8	113
813H49A	(716H0 x 760) x F66-13	9,370	31.17	15.0	9.6	123
813H32A	(754H0 x 716) x F66-13	9,130	31.93	14.3	6.1	116
813H41A	(716H29 x 757) x F66-13	9,080	31.00	14.6	10.8	125
813TH32	(754H0 x 716) x 713T	8,880	31.05	14.3	3.6	113

General MEAN of						
all varieties	9,440	31.78	14.9	6.0	Beets	
Significant Difference (19:1)	688	NS	0.81	2.33	per	
Coefficient of Variation (%)	8.15	5.04	6.06	43.64	100'	
Calculated F value	2.63*	NS	2.90*	12.29**	row	

\*Exceeds the 5% point of significance (F=2.16)

\*\*Exceeds the 1% point of significance (F=2.94)

VARIETY TEST, BRAWLEY, CALIFORNIA, 1969

(10 x 10 Latin square)  
(One-row plots)

Planted: September 9, 1968  
Harvested: June 12, 1969

Test 6

Variety	Description	Acre Yield		Sucrose Percent	Bolting Percent	Harvest Count Number
		Sugar	Beets			
		Pounds	Tons			
F68-413	Increase F66-13	10,670	34.69	15.4	10.2	137
F68-613	Increase 613	10,400	33.87	15.3	14.6	122
F67-13	Increase 413	10,360	33.66	15.4	10.6	135
813	8 YRS, 2 Suc. Sel. US 75	10,150	31.82	16.0	4.0	126
Y804	Inc. (YRS 534 x YRS 413)	9,910	32.28	15.3	19.6	118
713	7 YRS, 1 Suc. Sel. US 75	9,880	32.09	15.4	10.7	127
F66-13	Increase 413	9,850	32.57	15.1	10.8	132
813T	Increase 713T	9,130	30.34	15.0	7.1	108
730T	Increase 630T	7,440	25.56	14.6	0.4	110
868	Increase F57-68 (US 75)	6,180	21.51	14.4	2.8	126
General MEAN of						
all varieties		9,400	30.84	15.2	9.1	Beets
Significant Difference (19:1)		697	2.23	0.45	4.08	per
Coefficient of Variation (%)		18.22	15.20	8.07	80.95	100'
Calculated F value		34.55**	27.46**	7.88**	15.57**	row

\*\*Exceeds the 1% point of significance ( $F=2.67$ )



VARIETY TEST, BRAWLEY, CALIFORNIA, 1969

(10 replications of each variety)  
(Two-row plots)

Planted: September 9, 1968  
Harvested: July 14, 1969

Test 7

Variety	Description	Acre Yield		Sucrose Percent	Bolting Percent	Harvest Count Number
		Sugar	Beets			
		Pounds	Tons			
813TH8	(562H0 x 546) x 713T	11,450	39.13	14.64	2.1	112
813H8	(562H0 x 546) x 713A	11,040	37.66	14.67	0.4	136
U713H8	US H9B	10,810	36.55	14.80	2.5	132
U713H4	US H9A	10,680	36.22	14.75	1.2	132
664H4	US H7	9,140	32.08	14.24	0.6	134
664H8	US H7A	9,030	31.61	14.30	1.5	126
Mean		10,360	35.54	14.57	1.38	Beets
LSD (.05)		583	2.04	NS	1.09	per
Coefficient of Variation		6.24	6.36	3.51	87.39	100'
F value		25.01*	18.11*	NS	4.66*	row

\*Exceeds the 1% level of significance ( $F=3.47$ )

VARIETY TESTS, SALINAS, CALIFORNIA, 1968-69

Location: USDA Agricultural Research Station

Soil type: Sandy loam.

Previous crops: Barley, 1966; fallow, 1967; barley and purple vetch cover crop, 1968.

Fertilizer used: 672 lbs. per acre 0:10:10, preplant, broadcast and disced in before listing.  
84 lbs. per acre actual N, preplant.  
57 lbs. per acre of actual N as ammonium sulfate was sidedressed April 17, 1969.  
60 lbs. per acre of actual N, as  $\text{NH}_3$ , was applied through the sprinkler irrigation system June 25-27, 1969.

Planting dates: Bolting tests, November 14, 1968.  
Yield tests, January 9-10, 1969.

Thinning dates: Bolting tests, January 8, 1969.  
Yield tests, March 5-8, 1969.

Harvest dates: Bolting tests, September 9-12, 1969.  
Yield tests, September 22 - October 2, 1969.

Irrigations: As required at 10-14 day intervals starting April 29, 1969.

Diseases and insects: Virus yellows symptoms were first observed scattered throughout noninoculated tests about mid-June. By harvest yellows virus symptoms were moderately severe. The bolting and yield trial plantings were sprayed twice at rates of 2 pints per acre with Meta-systox R on April 1 and May 7, 1969, for control of green peach aphid. To control leaf miner three spray applications of Diazinon at rates of 1 1/2 pints per acre were made between mid-June and August 1, 1969.

Experimental design: Two bolting evaluation tests of 30 and 72 entries were planted in randomized block designs with four replications each. Single-row plots of 68 and 33 feet, respectively, were used. Four January planted yield tests were randomized block designs and one test was a 10 x 10 latin square. Three tests had single-row plots and two had two-row plots. One test of 43 entries was inoculated with yellows viruses. All plots were 53 feet long planted on beds spaced 28 inches apart.

Sugar analysis: Determined from two samples per plot of approximately ten roots each at the sugar analytical laboratory, United States Agricultural Research Station, Salinas, California.

VARIETY TEST, SALINAS, CALIFORNIA, 1969

(4 replications of each variety)  
(Single-row plots)

Planted: November 14, 1968  
Harvested: September 9, 1969

Variety	Description	Acre Yield		6/30		8/12		9/5		6/23		Harvest	
		Sugar Pounds	Berets Tons	Sucrose Percent	Bolting Percent	Bolting Percent	Bolting Percent	Bolting Percent	Bolting Percent	Mildew Percent	Mildew Percent	Count	Number
813H8	(562H0 x 546) x 713A	15,010	47.91	15.6	2.7	6.8	6.8	9.4	4.7			167	
Y803H4	(562H0 x 569) x Y603	14,460	45.23	16.0	2.8	6.7	6.7	11.7	7.7			146	
U813H4	UE H9A	14,410	47.86	15.1	7.2	15.8	15.8	20.0	5.5			165	
813H46	(716H29 x 718) x 713A	14,360	46.47	15.4	1.9	7.5	7.5	11.9	4.0			163	
613H4	(562H0 x 569) x 513	14,270	46.65	15.3	10.3	17.1	17.1	25.3	2.0			164	
813H45	(705H25 x 718) x 713A	14,220	46.65	15.3	5.6	13.6	13.6	20.7	3.3			164	
Y804H8	(562H0 x 546) x Y704	14,190	45.98	15.4	7.1	11.1	11.1	16.8	4.5			161	
713H4	(562H0 x 569) x 613A	14,070	46.33	15.2	3.1	8.2	8.2	14.5	3.4			167	
813TH32	(754H0 x 716) x 713T	13,980	49.43	14.1	6.3	14.0	14.0	21.5	6.1			154	
813H48	(716H29 x 734) x 713A	13,710	45.68	15.0	16.2	29.8	29.8	34.1	4.6			162	
813TH41	(716H29 x 757) x 713T	13,540	44.98	15.1	7.3	12.8	12.8	18.7	8.9			166	
813TH40	(754H0 x 760) x 713T	13,480	44.47	15.2	12.6	28.4	28.4	32.3	7.5			159	
813H50	(705H24 x 705) x 713A	13,230	41.83	15.9	8.2	13.4	13.4	20.6	2.9			170	
813H47	(705H25 x 751) x 713A	13,230	42.42	15.6	4.8	8.6	8.6	11.1	5.7			167	
813TH49	(716H0 x 760) x 713T	13,190	43.66	15.1	5.0	14.5	14.5	21.7	11.4			153	
868H4	(562H0 x 569) x F57-68	13,190	40.46	16.3	5.7	9.8	9.8	13.5	5.6			156	
813H44	(705H24 x 714) x 713A	13,170	42.23	15.6	9.9	19.9	19.9	26.4	2.3			149	
U813H8	UE H9B	13,080	43.24	15.1	8.6	13.5	13.5	20.1	6.9			169	
664H4	UE H7	12,860	42.53	15.1	7.3	16.9	16.9	22.0	9.9			166	
813H42	(754H4 x 704) x 713A	12,860	41.62	15.4	8.9	16.9	16.9	25.6	7.3			165	



VARIETY TEST, SALINAS, CALIFORNIA, 1969 continued

(4 replications of each variety)  
(Single-row plots)

Planted: November 14, 1968  
Harvested: September 9, 1969

Variety	Description	Acre Yield		6/30	8/12	9/5	6/23	Harvest
		Sugar	Beets	Bolting	Bolting	Bolting	Mildew	Count
		Pounds	Tons	Percent	Percent	Percent	Percent	Number
664H8	UB H7A	12,810	40.87	9.2	17.1	22.4	10.5	162
813	Inc. 8 YRS, 2 SS US 75	12,710	41.64	4.9	9.5	13.5	6.8	161
813T	Inc. 713T	12,390	42.96	4.2	9.0	11.0	5.1	144
730T	Inc. 630T	12,360	38.93	2.2	4.2	4.5	7.2	157
F68-613	Inc. 7 YRS IE 75	11,940	43.26	13.5	22.4	27.0	5.8	158
664H2	US H6	11,880	36.21	5.2	17.9	20.8	8.2	154
413C	5 YRS US 75	11,420	39.35	9.2	14.5	16.6	14.4	155
868	Inc. F57-68 (US 75)	11,180	37.71	11.8	15.1	21.9	12.9	167
F68-413	Inc. F66-13	11,000	40.76	10.7	20.3	23.8	14.7	167
F57-68	US 75	8,640	27.86	9.1	15.9	18.6	22.7	103

Mean	13,030	42.84	15.2	7.4	14.4	19.3	7.4	Beets
LSD (.05)	1,439	4.18	0.91	3.98	5.86	5.69	6.82	per
Coefficient of Variation	7.93	7.01	4.31	38.68	29.29	21.21	66.08	100'
F value	6.47**	7.97**	4.05**	6.12**	8.10**	10.79**	3.24**	row

\*\*Exceeds the 1% point of significance (F=1.56)

# VARIETY TEST, SALINAS, CALIFORNIA, 1969

(4 replications of each variety)  
(Single-row plots)

Planted: November 14, 1968  
Harvested: September 10, 1969

Variety	Description	Acre Yield		Sucrose Percent	6/30		8/12		9/5		6/23		Harvest Count
		Sugar Pounds	Beets Tons		Bolting Percent	Bolting Percent	Bolting Percent	Bolting Percent	Mildew Percent				
Hybrids and Open-pollinated Lines													
730TH32	(754H4 x 716) x 330T	15,310	50.15	15.3	3.8	6.9	8.3	9.1	145				
713H37	(562H0 x 702) x 613A	14,190	45.66	15.5	3.4	9.3	15.6	5.4	155				
713H39	(715H3 x 707) x 613A	13,840	45.03	15.4	17.2	27.3	35.4	4.1	167				
713H29	754H0 x 613A	13,720	45.53	15.0	4.2	9.3	15.8	16.1	144				
730TH35	(764H3 x 754) x 330T	13,690	44.62	15.4	6.2	9.4	11.1	7.5	139				
F67-34	Inc. 534	13,620	42.16	16.2	3.3	10.9	14.6	22.3	140				
713TH32	(754H4 x 716) x 413T	13,370	44.71	15.0	6.8	17.1	21.4	7.3	135				
775TH32	(754H4 x 716) x 6757	13,310	44.71	14.8	5.1	12.2	20.9	22.1	145				
713H36	(562H0 x 707) x 613A	13,140	43.02	15.3	9.2	18.9	33.0	7.6	148				
Y804	Inc. (YRS 534 x YRS 413)	13,040	42.51	15.3	13.5	20.4	26.5	13.2	126				
713H30	(760H4 x 705) x 613A	13,040	42.16	15.5	10.2	25.5	29.7	11.7	139				
F68-546H4	F63-563H0 x F66-546	12,830	40.44	15.9	1.4	3.9	4.3	1.5	156				
713H38	(760H4 x 702) x 613A	12,810	41.78	15.3	7.8	18.8	23.8	5.3	148				
713TH34	760H0 x 413T	12,740	46.17	13.8	5.6	13.4	18.3	19.9	137				
7718H31	(764H3 x 705) x 718	12,590	41.62	15.2	4.7	13.6	18.8	13.4	145				
Y803	Inc. Y603	12,540	40.48	15.5	4.0	12.5	14.5	30.3	131				
F68-546H5	564H0 x 546	12,480	38.31	16.3	3.7	6.3	6.7	3.7	146				
7718H32	(754H4 x 716) x 6718	12,480	42.29	14.7	2.1	4.6	8.7	27.6	150				
F68-546H3	F66-562H0 x F66-546	12,410	37.74	16.4	1.9	4.7	7.4	3.0	161				
7751H31	(764H3 x 705) x 6751	12,190	39.68	15.4	2.1	2.1	5.1	24.5	120				
7705H30	(760H4 x 705) x 5705	12,150	40.03	15.2	9.1	20.9	28.9	11.0	143				
F67-569H3D	F66-562H0 x F64-569	12,010	37.42	16.0	7.5	12.2	16.5	2.8	132				
F68-550H5	F67-564H0 x F64-550	12,000	39.46	15.2	1.6	8.0	9.1	4.8	145				
F67-546H3	F66-562H0 x F63-546	11,900	36.59	16.3	2.3	6.9	8.0	3.1	137				

VARIETY TEST, SALINAS, CALIFORNIA, 1969 continued

(4 replications of each variety)  
(Single-row plots)

Planted: November 14, 1968  
Harvested: September 10, 1969

Variety	Description	Acres Yield		6/30		8/12		9/5		6/23		Harvest Count
		Sugar		Sucrose Percent	Bolting Percent	Bolting Percent	Bolting Percent	Bolting Percent	Mildew Percent			
		Pounds	Tons									
8551H4	F63-563H0 x 6551	11,730	37.32	15.6	1.7	2.2	3.4	9.8	135			
7751H32	(754H4 x 716) x 6751	11,670	38.63	15.1	0.5	3.3	3.8	21.1	136			
8551H1	5564H0 x 6551	11,660	37.39	15.6	3.1	9.1	10.8	12.9	119			
7716H29	754H0 x 6716	11,650	41.24	14.1	1.1	2.1	6.8	35.2	149			
7734H33A	716H0 M- x 4734A	11,440	40.57	14.1	19.1	26.9	32.2	26.1	130			
7714H31	(764H3 x 705) x 6714	11,410	36.15	15.8	8.9	19.6	24.1	8.4	145			
7714H30	(760H4 x 705) x 6714	11,390	36.72	15.5	11.8	22.6	29.7	3.7	148			
7716H0	(716H3 x 716) x 6716	11,380	40.67	14.0	1.4	4.1	6.6	37.0	143			
F66-550H4	563H0 x 550	11,370	37.67	15.1	4.9	7.5	9.8	18.8	118			
F67-569H3C	F66-562H0 x F64-569	11,120	34.81	16.0	6.7	17.6	17.0	8.6	120			
7734H32	(754H4 x 716) x 4734A	11,070	39.17	14.1	12.0	26.7	32.6	24.0	137			
8597H3	F66-562H0 x 6597	10,980	32.93	16.7	4.0	14.0	18.7	7.9	135			
8522H2	7601H2 x 6522	10,760	32.68	16.5	7.2	12.3	17.7	13.2	137			
7760H33A	716H0 M- x 5760	10,750	36.97	14.5	21.7	37.2	44.1	31.8	135			
7760H29	754H0 x 5760	10,500	38.06	13.8	19.0	32.3	39.4	26.4	142			
7705H31	(764H3 x 705) x 5705	10,470	32.33	16.2	6.0	18.6	21.4	21.3	127			
8536H1	5564H0 x 6536	10,450	35.16	14.8	7.5	15.0	17.0	11.7	120			
8597H1	5564H0 x 6597	10,420	32.74	15.9	5.6	12.7	15.3	11.6	115			
7753H0	(754H4 x 754) x 5753A	10,180	34.94	14.5	4.7	12.8	17.1	35.2	133			
7754H0	(754H4 x 754) x 5754A	9,710	33.51	14.5	2.1	11.4	15.9	22.3	148			
8536H3	F66-562H0 x 6536	9,640	31.69	15.2	10.8	18.0	22.2	8.5	113			
8522H1	5564H0 x 6522	8,450	28.07	15.1	3.3	10.5	12.9	17.8	117			
7760H0	(760H4 x 760) x 5760	8,450	28.86	14.7	47.5	60.4	70.7	26.5	133			
Acc. 117	FC 601	4,820	16.96	14.2	0.0	1.7	1.7	31.4	123			



(4 replications of each variety)  
(Single-row plots)Planted: November 14, 1968  
Harvested: September 10, 1969

Variety	Description	Acre Yield		6/30		8/12		9/5		6/23		Harvest Count
		Sugar	Beets	Bolting	Sucrose	Bolting	Bolting	Bolting	Bolting	Mildew		
		Pounds	Tons	Percent	Percent	Percent	Percent	Percent	Percent	Percent		
Inbred Lines												
7716	Inc. YRS (062-3 x B25-9)	10,930	36.97	0.0	14.8	0.5	0.5	0.5	33.1	154		
7718	Inc. (563 x 716-6)	10,780	35.22	4.1	15.3	11.4	16.5	10.5	139			
7751	Inc. (563 x 716-18)	10,740	35.92	0.0	15.0	0.5	1.9	14.2	160			
F67-563HO	F63-563HO x F63-563	10,390	33.35	4.5	15.6	10.8	11.8	2.4	154			
F68-564HO	F67-564HO x F67-564	10,280	33.89	13.3	15.2	20.9	22.4	3.0	150			
F66-562HO	562HO x 562	10,250	33.79	11.6	15.1	24.5	29.8	6.1	148			
7734	Inc. YRS (927-35 x 577-2)	9,860	35.77	23.1	13.8	32.3	38.0	22.3	143			
7757	Inc. YRS (911 x 716-4)	9,830	35.16	19.3	14.0	21.9	24.2	25.0	146			
F67-564HO	5564HO x 5564	9,820	31.60	9.0	15.6	14.1	15.9	6.8	117			
F66-550	Inc. F64-550	9,560	34.37	7.6	13.9	14.6	18.2	11.3	151			
5563HO	563HO x 563	9,180	30.67	27.0	15.0	38.5	46.6	6.9	147			
F66-569	Inc. F59-569	8,970	30.01	21.2	15.0	34.3	39.8	10.7	151			
8502	Inc. 6502	8,950	29.43	11.6	15.1	26.8	30.1	20.3	131			
F66-562	Inc. 562	8,850	28.29	19.1	15.7	23.2	33.0	8.1	152			
5563	Inc. 563	8,820	28.92	22.1	15.3	36.6	38.1	3.3	141			
F67-564	Inc. 5564	8,520	27.91	16.7	15.4	29.3	33.4	4.4	128			
F67-563	Inc. F63-563	8,220	26.76	7.5	15.2	15.0	18.3	11.9	134			
7714	Inc. (2563 x 2743)	8,070	26.54	27.8	15.2	30.5	39.4	6.0	145			
6705	Inc. (121 x 2743)	7,380	24.18	20.3	15.1	24.4	27.6	15.9	123			
5760	Inc. (911 x 9717)	6,500	23.16	60.4	13.9	72.2	80.3	13.6	136			
8522-23C2	Inc. 6522-23C1	6,320	24.76	39.5	12.8	49.4	53.7	7.7	128			
8522-21C2	Inc. 6522-21C1	5,670	19.16	7.5	14.9	12.5	13.8	14.8	106			
8522-3-5C2	Inc. 6522-3-5	5,470	20.24	28.2	13.5	36.0	41.8	22.2	128			
F60-512	NB 6	4,650	16.55	0.0	14.0	0.0	0.0	62.0	96			
Main												
LSD (.05)		10,710	35.42	15.1	10.4	17.7	21.8	15.2	Beets			
Coefficient of Variation		1,694	5.21	1.02	8.09	9.88	10.39	18.25	per			
F value		11.24	10.46	4.79	55.28	39.72	33.90	85.62	100'			
		14.29**	14.88**	4.59**	14.90**	14.93**	17.27**	2.88**	100'			

\*\*Exceeds the 1% point of significance (F = 1.94)

VARIETY TEST, SALINAS, CALIFORNIA, 1969

(10 replications of each variety)  
(Two-row plots)

Planted: January 9, 1969  
Harvested: September 29, 1969

Variety	Description	Acre Yield		Sucrose Percent	Bolting Percent	Mildew Percent	Harvest	
		Sugar Pounds	Beets Tons				Count	Number
Y803H4	569H3 x Y603	15,570	46.54	16.7	0.9	14.5	128	
813H48	(716H29 x 734) x 713A	15,140	46.40	16.3	1.5	19.1	125	
Y804H8	546H3 x Y704	14,910	45.47	16.4	1.5	20.2	122	
813H50	(705H24 x 705) x 713A	14,720	44.41	16.5	0.7	14.5	132	
813H44	(705H24 x 714) x 713A	14,720	43.02	17.1	1.4	15.8	116	
713H4	569H3 x 613A	14,660	43.97	16.7	0.4	17.0	123	
F66-13H11	(563H0 x 550) x 413	14,620	45.64	16.0	1.7	18.9	128	
U813H8	US H9B	14,560	44.02	16.5	1.2	16.5	130	
813H46	(716H29 x 718) x 713A	14,560	44.93	16.2	0.4	21.3	124	
813H8	546H3 x 713A	14,480	44.15	16.4	0.4	18.3	121	
813H47	(705H25 x 751) x 713A	14,420	42.25	17.1	0.3	19.6	128	
613H4	569H3 x 513	14,290	44.58	16.0	1.8	16.2	120	
813H42	(754H4 x 704) x 713A	14,270	43.21	16.5	0.9	17.0	122	
813H45	(705H25 x 718) x 713A	14,160	41.83	16.9	1.0	22.2	116	
U813H4	US H9A	13,700	42.79	16.0	1.0	17.1	128	
664H8	US H7A	13,380	40.35	16.6	1.8	21.9	127	
664H4	US H7	13,260	39.46	16.8	1.2	19.5	130	
868H4	569H3 x F57-68	12,620	38.12	16.5	1.6	16.6	126	
Mean		14,330	43.40	16.5	1.1	18.1	Beets	
LSD (.05)		890	2.39	0.60	0.79	NS	per	
Coefficient of Variation		7.03	6.24	4.09	82.30	35.92	100'	
F value		4.97**	7.31**	2.43**	3.41**	NS	row	

\*\*Exceeds the 1% point of significance (F=2.12)

VARIETY TEST, SALINAS, CALIFORNIA, 1969  
Inoculated with yellows

(10 replications of each variety)  
(Single-row plots)

Planted: January 10, 1969  
Harvested: September 22, 1969

Variety	Description	Acre Yield		Sucrose Percent	Bolting Percent	Mildew Percent	Harvest Count
		Sugar Pounds	Berets Tons				
713H39	(715H3 x 707) x 613A	10,760	34.56	15.6	1.5	14.0	136
813H48	(716H29 x 734) x 713A	10,610	35.01	15.1	0.5	19.0	131
813TH41	(716H29 x 757) x 713T	10,540	34.75	15.1	0.3	12.8	125
Y803H4	569H3 x Y603	10,510	33.56	15.6	0.1	16.3	123
813H50	(705H24 x 705) x 713A	10,480	33.65	15.5	0.3	16.3	131
813H45	(705H25 x 718) x 713A	10,400	33.79	15.3	0.1	16.7	128
813H8	546H3 x 713A	10,280	32.47	15.8	0.0	17.8	137
813H44	(705H24 x 714) x 713A	10,240	33.23	15.4	0.3	10.8	124
813TH32	(754H0 x 716) x 713T	10,190	34.39	14.8	0.6	13.1	129
Y803	Inc. Y603	10,160	31.23	16.2	0.3	24.1	121
813H46	(716H29 x 718) x 713A	10,110	32.48	15.5	0.0	15.7	133
813TH49	(716H0 x 760) x 713T	10,070	33.21	15.1	0.3	16.5	120
813TH40	(754H0 x 760) x 713T	10,020	34.13	14.6	2.0	14.6	126
713H30	(760H4 x 705) x 613A	9,940	32.01	15.5	1.8	12.8	129
713B	8 YRS US 75	9,910	33.12	15.0	0.7	18.5	131
813H42	(754H4 x 704) x 713A	9,890	32.02	15.4	0.4	12.7	134
713H4	569H3 x 613A	9,710	31.64	15.3	0.2	16.2	127
F66-13H11	(563H0 x 550) x 413	9,490	31.57	15.0	1.3	17.3	134
813H47	(705H25 x 751) x 713A	9,470	30.30	15.6	0.0	18.9	133
713H38	(760H4 x 702) x 613A	9,390	30.56	15.3	1.5	14.6	126
813	Inc. 8 YRS, 2 SS US 75	9,330	30.51	15.2	0.2	22.6	116
U813H8	546H3 x F66-13 (US H9B)	9,240	29.75	15.5	1.2	15.3	138
814	Imperial V. Sel. 713	9,230	30.68	15.0	0.3	21.5	122
Y804	Inc. (YRS 534 x YRS 413)	9,170	30.61	14.9	0.9	26.6	114



VARIETY TEST, SALINAS, CALIFORNIA, 1969 continued  
Inoculated with yellows

(10 replications of each variety)  
(Single-row plots)

Planted: January 10, 1969  
Harvested: September 22, 1969

Variety	Description	Acre Yield		Sucrose Percent	Bolting Percent	Mildew Percent	Harvest	
		Sugar Pounds	Beets Tons				Count	Number
613H4	569H3 x 513	9,000	29.98	15.0	0.7	18.0		127
F68-613	Inc. 7 YRS US 75	8,870	30.01	14.7	1.4	28.4		132
U813H4	569H3 x F66-13 (US H9A)	8,720	29.08	14.9	0.2	16.4		136
Y801	YRS Y601	8,710	28.62	15.1	5.0	26.1		134
713	Inc. 7 YRS, 1 SS US 75	8,550	28.34	15.0	0.0	29.4		120
7734H32	(754H0 x 716) x 4734A	8,540	29.70	14.3	1.4	24.8		120
F68-413	Inc. 5 YRS US 75	8,170	27.87	14.6	0.8	26.5		135
Y804H8	546H3 x Y704	8,070	26.83	15.0	1.1	23.6		101
Y601	Inc. Y501	8,040	26.52	15.1	13.8	22.1		123
7705H30	(760H4 x 705) x 5705	7,970	25.02	15.9	1.7	11.9		130
730T	Inc. 630T	7,750	25.78	15.0	0.0	12.7		127
813T	Inc. 713T	7,560	26.15	14.4	0.4	17.9		109
7718H31	(764H3 x 705) x 6718	7,220	24.41	14.7	1.7	20.1		118
664H4	569H3 x 664 (US H7)	7,070	23.65	14.9	0.3	23.0		130
7751H31	(764H3 x 705) x 6751	6,930	22.22	15.5	0.5	20.3		130
868H4	569H3 x F57-68	6,480	22.02	14.6	0.2	11.5		129
F66-64	HFS 663	6,210	21.10	14.6	0.2	28.3		131
868	Inc. F57-68 (US 75)	5,970	20.31	14.6	0.1	20.0		136
Y802	2 YRS 264	5,130	17.52	14.6	0.8	6.2		118
Mean		8,930	29.40	15.1	1.0	18.4	Beets	
LSD (.05)		671	2.03	0.46	1.05	6.85	per	
Coefficient of Variation		8.57	7.87	3.48	115.22	42.45	100'	
F value		34.47**	35.66**	6.24**	33.12**	4.79**	row	

\*\*Exceeds the 1% point of significance (F=1.64)



VARIETY TEST, SALINAS, CALIFORNIA, 1969

(10 replications of each variety)  
(Single-row plots)

Planted: January 10, 1969  
Harvested: September 24, 1969

Variety	Description	Acre Yield		Sucrose Percent	Bolting Percent	Mildew Percent	Harvest Count
		Sugar Pounds	Beets Tons				
713H39	(715H3 x 707) x 613A	12,880	40.69	15.8	1.4	15.7	125
713H38	(760H4 x 702) x 613A	12,510	39.87	15.6	1.5	14.7	120
713H30	(760H4 x 705) x 613A	12,080	37.46	16.1	2.9	16.1	111
713B	8 YRS 15 75	11,710	38.22	15.3	0.4	20.4	122
Y803	Inc. Y603	11,650	34.93	16.6	1.2	19.2	114
Y801	YRS Y601	11,100	36.24	15.3	6.1	26.4	119
Y804	Inc. (YRS 534 x YRS 413)	11,060	35.69	15.4	1.4	29.4	115
814	Imperial V. Sel. 713	10,850	35.00	15.5	0.9	27.9	120
F68-613	Inc. 7 YRS 15 75	10,820	37.03	14.5	1.3	28.8	122
713	Inc. 7 YRS, 1 SS US 75	10,580	34.05	15.5	0.8	28.4	115
813	Inc. 8 YRS, 2 SS 15 75	10,450	34.16	15.2	0.2	24.2	112
Y601	Inc. Y501	10,390	34.37	15.0	15.9	22.7	116
730T	Inc. 630T	10,310	32.94	15.6	0.2	13.6	110
F68-413	Inc. 5 YRS US 75	10,060	34.51	14.5	1.1	30.6	122
813T	Inc. 713T	9,290	30.74	15.1	1.8	20.0	96
Y802	2 YRS 264	9,090	28.95	15.7	0.5	9.5	111
868	Inc. F57-68 (US 75)	8,970	29.58	15.1	0.6	21.9	123
F66-64	IRS 663	8,840	29.15	15.1	0.3	32.3	126
Mean		10,700	34.64	15.4	2.1	22.3	Beets
LSD (.05)		708	1.96	0.62	1.59	6.91	per
Coefficient of Variation		7.49	6.39	4.53	84.59	35.04	100'
F value		21.91**	24.16**	5.45**	42.19**	7.21**	row

\*\*Exceeds the 1% point of significance (F=2.12)

DIPLOID-TRIPLIOD COMPARISON TEST, SALINAS, CALIFORNIA, 1969

(10 x 10 Latin Square)  
(Two-row plots)

Planted: January 9, 1969  
Harvested: October 1, 1969

Variety	Description	Acre Yield		Sucrose Percent	Bolting Percent	Mildew Percent	Harvest Count
		Sugar Pounds	Beets Tons				
813TH49	(716H0 x 760) x 713T	15,160	45.72	16.6	1.3	14.0	117
813TH49A	(716H0 x 760) x F66-13	15,090	46.47	16.3	2.7	16.4	131
813TH40	(754H0 x 760) x 713T	15,050	46.39	16.2	2.5	13.5	120
813TH41A	(716H29 x 757) x F66-13	14,990	45.00	16.6	1.4	19.4	124
813TH8	(562H0 x 546) x 713T	14,960	45.76	16.4	1.1	14.0	104
813TH32	(754H0 x 716) x 713T	14,910	47.09	15.8	0.8	15.0	117
813TH32A	(754H0 x 716) x F66-13	14,620	46.58	15.7	0.4	21.7	122
813TH40A	(754H0 x 760) x F66-13	14,590	45.43	16.1	4.0	15.5	123
813TH41	(716H29 x 757) x 713T	14,540	45.85	15.9	1.1	15.3	112
813TH8A	(562H0 x 546) x F66-13	14,400	44.00	16.3	2.1	17.8	113
Mean		14,830	45.83	16.2	1.7	16.2	Beets per 100'
LSD (.05)		NS	1.61	0.53	1.12	3.33	100'
Coefficient of Variation		6.71	5.09	5.53	95.78	51.42	row
F value		NS	2.42*	2.92**	7.27**	4.94**	

\*Exceeds the 5% point of significance (F=2.01)

\*\*Exceeds the 1% point of significance (F=2.67)

EUROPEAN VARIETY TEST, SALINAS, CALIFORNIA, 1969

(10 replications of each variety)  
(Single-row plots)

Planted: January 9, 1969  
Harvested: September 25, 1969

Variety	Acre Yield			Bolting Percent	Mildew Percent	Harvest Count Number
	Sugar Pounds	Beets Tons	Sucrose Percent			
US H9B	14,820	45.77	16.2	1.7	15.9	127
Hilleshog's Monohil, 126984	13,880	40.44	17.2	12.4	11.4	122
Hilleshog's 234, 1125016	13,820	40.27	17.2	1.4	12.6	126
Irish Triplold	13,630	38.86	17.5	2.8	12.9	117
Hilleshog's 81, 1126783	13,610	40.27	16.9	5.1	13.3	125
Sharpe's Klein E	12,940	39.58	16.3	4.1	20.6	102
Mean	13,790	40.86	16.9	4.6	14.4	Beets per 100' row
LSD (.05)	921	2.64	0.56	2.04	4.35	
Coefficient of Variation	7.41	7.16	3.65	49.41	33.43	
F value	3.56**	7.15**	7.25**	32.84**	4.85**	

\*\*Exceeds the 1% point of significance (F=3.45)

Drayton, North Dakota USDA and General Variety Test of California Varieties - Test #985-1

by American Crystal Sugar Company

Variety	Description	Gross Sugar lbs/A	Gross Sugar - KSL*	Tons Beets /A	% Sucrose	Impurity Index
US H7	(562H0 x 569) x 264	5903	4587	23.30	12.51	1528
US H9A	(562H0 x 569) x 413	5872	4479	23.85	12.35	1554
US H9B	(562H0 x 546) x 413	6071	4617	25.52	11.90	1607
F66-13H11	(563H0 x 550) x 413	5973	4553	24.83	12.04	1609
813H8	(562H0 x 546) x 813	5573	4378	22.64	12.25	1472
813H44	(705H24 x 714) x 813	5453	4063	22.51	12.10	1651
813H45	(705H25 x 718) x 813	6115	4710	25.35	12.13	1530
813H47	(705H25 x 751) x 813	5858	4526	23.88	12.39	1525
813H50	(705H24 x 760) x 813	5461	4282	22.09	12.29	1499
813TH32	(754H0 x 716) x 413T	5754	4272	24.50	11.67	1719
813TH40	(754H0 x 760) x 413T	5960	4469	25.57	11.57	1689
813TH41	(716H29) x 757) x 413T	5510	4073	23.82	11.68	1745
Am #2 Hybrid "B"	SP 6322-0 x SL (129 x 133)	5942	4668	23.28	12.84	1468
Am #3 Hybrid "N"	74842 x 546H3	5927	4618	22.74	13.13	1447
Am #5 Hybrid "T"	62-4TL8 x 547H1	5601	4413	21.36	13.21	1409
64-208 x 66-569H3	64-208 x 66-569H3	5631	4436	21.97	12.86	1427
General Mean		5788	4447	23.58	12.31	1554
LSD (.05)		658	537	2.50	.33	103
F. Value		.92	1.16	2.23	22.96	10.44
C. V. %		9.84	10.46	9.20	2.32	5.74

\*Minus Known Sugar Loss.

Variance Table						
Source of Variation	D/F	Gross Sugar	Gross Sugar - KSL	Tons Beets/A	% Sucrose	Impurity Index
Replications	5	512,738	2,803,492	7.9682	7.2851	1,685,073
Blocks	18	364,176	330,661	--	.3534	32,027
Varieties	15	288,897	226,321	10.4771	1.5168	65,855
Error	57	313,677	195,290	4.7042	.0661	6,494
Total	95					

Design: 4 x 4 Triple Lattice,  
6 replications, 16 entries.  
Plot Size: 2 rows, 35 feet  
long, 22 inch rows.  
Planted: May 21-23, 1969  
Harvested: September 25, 1969



Clarksburg USDA and General Variety Test #925-1

Fall Harvest

by American Crystal Sugar Company

Variety	Description	Gross Sugar Lbs/A	Gross Sugar - KSL*	Tons Beets /A	% Sucrose	Impurity Index
US H7	(562H0 x 569) x 264	6420	4867	30.55	10.55	1638
US H9A	(562H0 x 569) x 413	6818	5183	32.74	10.40	1596
US H9B	(562H0 x 546) x 413	6192	4680	31.08	10.00	1632
F66-13H11	(563H0 x 550) x 413	6784	5098	34.56	9.85	1649
813H8	(562H0 x 546) x 813	6656	5199	31.49	10.59	1477
813H44	(705H24 x 714) x 813	5996	4605	28.21	10.67	1565
813H45	(705H25 x 718) x 813	6507	4882	31.63	10.31	1662
813H47	(704H25 x 751) x 813	6670	5068	30.28	10.98	1636
813H50	(705H24 x 760) x 813	6621	5197	30.16	10.92	1465
813TH32	(754H0 x 716) x 413T	5483	3890	29.51	9.34	1935
813TH40	(754H0 x 760) x 413T	6584	4044	30.42	9.13	1891
813TH41	(716H29 x 757) x 413T	5566	3966	29.34	9.41	1922
Am #2 Hybrid "B"	SP 6322-0 x SL (129 x 133)	6099	4713	28.78	10.51	1524
Am #3 Hybrid "N"	74842 x 546H3	5491	4186	25.59	10.69	1587
Am #5 Hybrid "T"	62-4T18 x 547H1	5561	4274	25.86	10.80	1529
64-208 x 66-569H3	64-208 x 66-569H3	6418	4944	29.19	10.93	1567
General Mean		6179	4675	29.96	10.32	1642
ISD (.05)		698	573	3.31	.58	123
F. Value		4.37	5.65	3.99	9.40	14.03
C. V. %		9.77	10.61	9.57	4.92	6.52

\* Minus known sugar loss.

Variance Table					
Source of Variation	D/F	Gross Sugar	Gross Sugar - KSL	Tons Beets/A	Impurity Index
Replications	5	3,946,995	4,494,084	22.2919	432,593
Blocks	18	441,934	333,112	10.0121	42,526
Varieties	15	1,508,818	1,285,425	31.0085	131,482
Error	57	345,494	227,503	7.7795	9,373
Total	95				

Design: 4 x 4 Triple Lattice,  
6 replications, 12 entries.

Plot Size: 2 rows, 35 feet long,  
22 inch rows.

Planted: March 28, 1969

Harvested: August 18, 1969

# VARIETY TEST, CLARKSBURG, CALIFORNIA, 1968-69

by American Crystal Sugar Company

Spring Harvest

Variety	Description	Gross Sugar		Tons Beets	% Sucrose	Impurity Index
		Lbs/A	KSL			
66-13H11	(563HO x 550) x 413 V. Y. Res.	10,088	9412	29.09	17.34	447
HO x 413	ACS MS x Virus Yellow Res.	10,035	9371	28.59	17.55	441
66-13H11	(562HO x 569) x 413 V. Y. Res.	9,984	9298	27.95	17.86	458
IS H9A	(562HO x 569) x 413 V. Y. Res.	9,780	9105	27.41	17.84	460
IS H9B	546H3 x C-413	9,775	9150	27.63	17.69	426
Mon #2 Hybrid "A"	CTR-LSR-RRR Monogerm	9,707	9155	27.67	17.54	379
4842 x 546H3	Klein Hybrid Multigerm	9,619	8961	26.63	18.06	456
IS H7	(562HO x 569) x 663	9,324	8634	25.90	18.00	493
Mon #2 Monogerm	62-GH #2-1-0	8,788	8267	24.70	17.79	395
69H3 x 58-205-0	Non-Bolting CTR x Am #5 Selection	8,618	8021	23.94	18.00	462
22-47L8 x 547H1	Triplaid	8,352	7847	22.82	18.30	403
General Mean		9,475	8844	26.60	17.81	444
ISD (.05)		863	--	2.39	.26	31
P. Value		--	--	5.06**	7.99**	12.40**
S. V. %		9.73	--	9.61	1.56	7.41

a/For gross sugar SE lbs. sucrose =  
mean lbs. sucrose x

$$\sqrt{\frac{(\text{SE lbs. beets})^2 + (\text{SE \% sucrose})^2}{(\text{Mean lbs. beets}) (\text{Mean \% sucrose})}}$$

Variance Table a/

Source of Variation	D/F	Mean Squares (variance)		
		Tons Beets	Percent Sucrose	Impurity Index
Replications	8	5154.87	.8987	4,956
Varieties	11	2136.26	.6182	13,423
Error	88	422.40	.0773	1,082
Total	107	605.55	.1943	2,640

Plot size: 2 row plots, 35 feet long, 22 inch rows.  
Design: 12 entries, 9 replications in Randomized Block.  
Planted: September 2, 1968  
Harvested: March 27, 1969

1968 TRACY FALL HARVEST VARIETY TEST

Variety	Description	Gross Sugar Lb/A	Tons Beets /A	% Sugar	Beets /100	% Bolting
734H1	569H3x534 and 546H3x534	11741	44.25	13.31	143	36.0
744H8	546H3 x 544	11251	44.05	12.76	142	38.9
744H4	569H3 x 544	11186	43.19	12.89	149	40.4
USH9A	569H3 x 4413 (WL 7279)	11155	42.31	13.18	150	41.7
713H4	569H3 x 713	11074	42.16	13.16	138	39.5
713H36	707H3 x 713	11027	41.61	13.25	147	58.1
F66-13H11	550H4 x 4413 (WL 6454)	10731	43.57	12.29	146	40.0
USH9B	546H3 x 4413 (WL 7326)	10658	42.55	12.49	155	44.4
Test Mean		10621.	41.28	12.86	143.	67.0
SE Mean		414.	1.09	0.33		
SE Mean/Test Mean (%)		3.9	2.63	2.60		
LSD (5%)		1153.2	3.03	0.93		

VARIANCE TABLE

Source	D.F.	Mean Squares		
		Gross Sugar	Tons Beets	Percent Sugar
Replication	7.	3637075.25	12.83	4.46
Variety	37.	3968249.59	47.50	2.17
Error	259.	1370569.52	9.45	0.89
Total	303.			
Calculated F Value		2.90**	5.02**	2.43**

\*\* Highly Significant (01 level)

Plot Size: 2-30 inch rows x 50 feet  
 Design: Randomized Complete Block with 38 entries 8 replications  
 Harvest: Yield - Entire Plot  
 % Sugar - 2-25 lb. samples per plot

Planted: April 24, 1968      Harvested: April 30, 1969  
 Cooperator: Reclaimed Island Land Co., Tracy, California

Remarks: Harvest delayed 5 months because of early rains and seepage from high river water. Tare was exceptionally high because of muddy conditions. Because of over-wintering bolting was a problem. No disease. Good test.

Extracted from a test of 38 varieties.

1969 TRACY FALL HARVEST VARIETY TEST

Variety	Description	Gross Sugar Lb/A	Tons Beets /A	% Sugar	Beets /100
USH9B	546H3 x C413 (WL 8225)	8421	39.39	10.65	117
USH9A	569H3 x C413 (WL 8514)	8232	39.01	10.65	113
813H45	(705H25 x 718) x 813	8129	35.78	11.38	95
813H47	(705H25 x 751) x 813	7709	34.38	11.22	88
813H8	546H3 x 813	7624	35.72	10.67	104
813TH49	(716H0 x 760) x 413T	7581	37.53	10.06	83
813TH32	(754H0 x 716) x 413T	7145	36.53	9.77	101
813TH41	(716H29 x 757) x 413T	7004	34.18	10.26	108
813H50	(705H24 x 760) x 813	6760	32.55	10.39	102
813H42	(754H4 x 704) x 813	6625	33.21	9.94	93
US75	P-55-68 (WL 716)	6536	32.01	10.19	76
Test Mean		7980.	36.92	10.80	97.
SE Mean		315.	1.06	0.26	
SE Mean/Test Mean (%)		3.9	2.88	2.44	
LSD (5%)		877.7	2.96	0.73	

VARIANCE TABLE

Source	D.F.	Gross Sugar	Tons Beets	Percent Sugar
Replication	8.	4524441.88	27.72	5.33
Variety	29.	4256157.44	57.76	2.75
Error	232.	893345.16	10.19	0.62
Total	269.			
Calculated F Value		4.76**	5.67**	4.41**

\*\* Highly Significant (.01 level)

Plot Size: 2-30 inch rows x 50 feet  
 Design: Randomized Complete Block with 30 entries 9 replications  
 Planted: May 14, 1969 Harvested: October 27, 1969  
 Harvest: Yield - Entire Plot  
           % Sugar - 2-25 lb. samples per plot  
 Cooperator: Reclaimed Island Land Co., Tracy, California  
 Remarks: Good test. Too many skips. No disease.

Extracted from a test of 30 varieties.



1969 TULARE FALL PLANT VARIETY TEST

Variety	Description	Gross Sugar lb/A	Tons Beets /A	% Sugar	Beets /100	% Bolting
813TH32	(754H0 x 716) x 413T	7087	31.47	11.59	161	0.2
813H50	(705H24 x 705) x 713A	6819	27.47	12.50	170	1.1
813TH49	(716H0 x 760) x 413T	6471	28.52	12.11	155	0.8
USH9A	569H3 x C413 (WL 7279)	6304	26.53	12.20	177	1.3
813H42	(754H4 x 704) x 713A	6184	26.67	11.94	169	0.7
813TH41	(716H29 x 757) x 413T	6111	27.33	11.76	165	0.3
F66-13H11	550H4 x C413 (WL 6454)	6110	27.12	11.56	174	0.7
813H47	(705H25 x 751) x 713A	6030	25.49	12.38	174	1.3
813H45	(705H25 x 718) x 713A	5993	25.37	12.30	167	1.9
USH9B	546H3 x C413 (WL 8513)	5915	25.81	11.88	180	2.0
USH7	569H3 x 664 (WL 6431)	5595	24.97	11.83	185	1.6
813H8	546H3 x 713A	5518	25.73	11.21	180	0.2
USH8	569H3 x NB7 (WL 6360)	5109	22.95	11.49	167	6.4
Test Mean		5931.	25.91	11.88	177.	4.9
SE Mean		535.	2.28	0.38		
SE Mean/Test Mean (%)		9.0	8.80	3.23		

VARIANCE TABLE

Source	D.F.	Gross Sugar	Tons Beets	Percent Sugar
Replication	6.	40985057.50	1428.14	48.94
Variety	19.	2162184.56	34.82	1.03
Error	114.	2002029.83	36.40	1.03
Total	139.			
Calculated F Value		1.08NS	0.96NS	1.00NS
NS = Non-Significant				

Plot Size: 2-30 inch rows x 50 feet  
 Design: Randomized Complete Block with 20 entries 7 replications  
 Planted: December 5, 1968 Harvested: August 21, 1969  
 Harvest: Yield - Entire Plot  
           % Sugar - 2-25 lb. samples per plot  
 Cooperator: Sherman Land and Cattle Co., Tulare, California  
 Remarks: Poor test. Rep 1 was lost due to nematode and rep 8 due to grass.  
           Uniformity lacking in stand, bolting and tops.

Extracted from a test of 20 varieties.

1969 TULARE WINTER PLANT VARIETY TEST

Variety	Description	Gross Sugar Lb/A	Tons Beets /A	% Sugar	Beets /100
813H45	(705H25 x 718) x 713A	6730	28.63	11.86	148
USH9B	546H3 x C413 (WL 8573)	6386	27.32	11.66	183
USH9A	569H3 x C413 (WL 7279)	6183	27.86	11.08	166
813H50	(705H24 x 705) x 713A	6063	26.59	11.37	171
813H8	546H3 x 713A	6021	25.40	11.93	165
813H47	(705H25 x 751) x 713A	5940	26.31	11.27	137
813H42	(754H4 x 704) x 713A	5594	24.89	11.28	138
USH7	569H3 x 664 (WL 6431)	5534	24.95	11.21	166
USH8	569H3 x NB7 (WL 6205)	4279	20.37	10.48	146
Test Mean		5819.	25.37	11.48	161.
SE Mean		300.	1.12	0.31	
SE Mean/Test Mean (%)		5.1	4.43	2.70	
LSD (5%)		834.7	3.13	0.86	

VARIANCE TABLE

Source	D.F.	Mean Squares		
		Gross Sugar	Tons Beets	Percent Sugar
Replication	7.	7849606.81	135.20	4.66
Variety	23.	1784145.59	29.50	1.59
Error	161.	718130.02	10.12	0.77
Total	191.			
Calculated F Value		2.48**	2.92**	2.08**

\*\* Highly Significant (.01 level)

Plot Size: 2-30 inch rows x 50 feet  
 Design: Randomized Complete Block with 24 entries 8 replications  
 Harvest: Yield - Entire Plot  
           % Sugar - 2-25 lb. samples per plot

Planted: March 24, 1969                      Harvested: September 16, 1969  
 Cooperator: Hercul Corp., Tulare, California

Remarks: Fair test. Late planted. Grass was a problem. Bad rot  
 in area of reps 2, 3, and 4. Rep 9 eliminated due to poor  
 conditions.

Extracted from a test of 24 varieties.

1969 IMPERIAL VALLEY EARLY HARVEST VARIETY TEST

Variety	Description	Gross Sugar Lb/A	Tons Beets /A	% Sugar	Beets /100	% Bolting
813H45	(705H25 x 718) x 813	5102	15.91	16.07	154	0.1
USH7	569H3 x 664 (WL 6431)	4922	15.26	16.16	148	0.2
813H8	546H3 x 813	4804	15.15	15.90	152	1.4
USH9B	546H3 x C413 (WL 7326)	4798	15.02	16.02	176	0.2
USH8	569H3 x NB7 (WL 6360)	4737	14.88	15.89	139	3.4
USH9A	569H3 x C413 (WL 7279)	4597	14.70	15.69	151	2.8
813TH32	(754H0 x 716) x 413T	4563	14.27	16.04	139	0.8
813H47	(705H25 x 751) x 813	4555	14.14	16.12	143	
813H42	(754H4 x 704) x 813	4523	14.14	16.04	147	1.5
F66-13H11	550H4 x C413 (WL 6454)	4462	13.96	15.98	157	0.7
USH7A	546H3 x 664	4409	13.72	16.11	146	
813TH49	(716H0 x 760) x 413T	4339	13.47	16.12	201	2.1
813TH41	(716H29 x 751) x 413T	4193	13.06	16.09	155	
Test Mean		4644.	14.52	16.04	153.	1.4
SE Mean		244.	0.80	0.22		
SE Mean/Test Mean (%)		5.3	5.50	1.38		

VARIANCE TABLE

Source	D.F.	Gross Sugar	Tons Beets	Percent Sugar
Replication	7.	1917476.33	35.86	4.87
Variety	29.	300829.18	3.33	0.31
Error	203.	478079.37	5.10	0.39
Total	239.			
Calculated F Value		0.63NS	0.65NS	0.78NS

NS = Non-Significant

Plot Size - 2-30 inch rows x 50 feet

Design - Randomized Complete Block with 30 entries 8 replications

Planted - September 7, 1968 Harvested - April 16, 1969

Harvest - Yield - Entire Plot

% Sugar - 2-25 lb. samples per plot

Cooperator - Don Cox, Brawley, California

Remarks - High salt concentration primarily in reps 1-3. Remainder of test appeared good and doing well. Some bolting with yellows and mosaic evident. Quite a lot of aphids, worms, and mites were present at harvest. Poor test.

Extracted from a test of 30 varieties.

1969 IMPERIAL VALLEY FIRST DATE OF HARVEST VARIETY TEST

Variety	Description	Gross Sugar Lb/A	Tons Beets /A	% Sugar	Beets /100
F66-13H11	550H4 x C413 (WL 6454)	3344	14.44	11.59	186
USH9B	546H3 x C413 (WL 7326)	2997	12.76	11.75	166
813H50	(705H24 x 760) x 813	2982	12.23	12.19	172
USH9A	569H3 x C413 (WL 7279)	2801	12.11	11.57	179
USH8	569H3 x NB7 (WL 6360)	2408	9.87	12.22	178
USH7	569H3 x 664 (WL 6431)	2185	9.18	11.87	163
Test Mean		2703.	11.37	11.92	173.
SE Mean		101.	0.41	0.15	
SE Mean/Test Mean (%)		3.7	3.59	1.22	
LSD (5%)		286.0	1.16	0.41	

VARIANCE TABLE

Source	D.F.	Mean Squares		
		Gross Sugar	Tons Beets	Percent Sugar
Replication	8.	241138.37	3.81	0.39
Variety	6.	1783169.45	37.93	0.78
Error	48.	91100.44		
Total	62.			
Calculated F Value		19.57**	25.32**	4.07**
** Highly Significant (.01 level)				

Plot Size: 2-32 inch rows x 50 feet  
 Design: Randomized Complete Block with 7 entries 9 replications  
 Harvest: Yield - Entire Plot  
 % Sugar - 2-25 lb. samples per plot

Planted: September 6, 1968      Harvested: April 14, 1969  
 Cooperator: Nelson Correll, Calipatria, California

Remarks: Beets were unusually small. Stand was fair to good.  
 Disease did not appear to be a factor in the results  
 of this test. No bolters.

Extracted from a test of 7 varieties.



1969 IMPERIAL VALLEY SECOND DATE OF HARVEST VARIETY TEST

Variety	Description	Gross Sugar Lb/A	Tons Beets /A	% Sugar	Beets /100	% Bolting
F66-13H11	550H4 x C413 (WL 6454)	5875	21.69	13.56	168	
813H50	(705H24 x 760) x 813	5842	20.30	14.44	163	
USH9B	546H3 x C413 (WL 7326)	5551	20.28	13.67	155	0.2
USH9A	569H3 x C413 (WL 7279)	5389	19.38	13.89	157	
USH8	569H3 x NB7 (WL 6360)	4447	16.73	13.33	166	
USH7	569H3 x 664 (WL 6431)	4348	16.35	13.33	164	
Test Mean		5102.	18.57	13.75	164.	0.0
SE Mean		181.	0.65	0.19		
SE Mean/Test Mean (%)		3.5	3.48	1.35		
LSD (5%)		513.1	1.83	0.53		

VARIANCE TABLE

Source	D.F.	Mean Squares		
		Gross Sugar	Tons Beets	Percent Sugar
Replication	7.	237855.04	6.90	1.12
Variety	6.	41804.04.66	47.45	1.27
Error	42.	260706.08	3.33	0.27
Total	55.			
Calculated F Value		16.03**	14.24**	4.64**

\*\* Highly Significant (.01 level)

Plot Size: 2-32 inch rows x 50 feet  
 Design: Randomized Complete Block with 7 entries 8 replications  
 Harvest: Yield - Entire Plot  
 % Sugar - 2-25 lb. samples per plot

Planted: September 6, 1968      Harvested: June 5, 1969  
 Cooperator: Nelson Correll, Calipatria, California

Remarks: Good test. Good uniform stand. No yellows symptoms were present at harvest; however, were reported during season.

Extracted from a test of 7 varieties.

1969 IMPERIAL VALLEY THIRD DATE OF HARVEST VARIETY TEST

Variety	Description	Gross Sugar	Tons Beets	% Sugar	Beets /100	% Bolting
		Lb/A	/A			
USH9A	569H3 x C413 (WL 7279)	7480	26.31	14.24	189	1.3
F66-13H11	550H4 x C413 (WL 6454)	7461	27.55	13.58	166	1.6
813H50	(705H24 x 760) x 813	7350	25.70	14.28	201	2.1
USH9B	546H3 x C413 (WL 7326)	7318	26.55	13.81	185	0.8
USH7	569H3 x 664 (WL 6431)	6070	22.63	13.39	169	0.3
USH8	569H3 x NB7 (WL 6360)	5564	20.95	13.29	168	1.9
Test Means		6755.	20.44	13.82	182.	1.2
SE Mean		231.	0.80	0.27		
SE Mean/Test Mean (%)		3.4	3.29	1.93		
LSD (5%)		655.8	2.28	0.76		

VARIANCE TABLE

Source	D.F.	Mean Squares		
		Gross Sugar	Tons Beets	Percent Sugar
Replication	8.	574871.54	2.25	0.87
Variety	6.	6147080.38	66.02	1.51
Error	48.	479001.04	5.81	0.64
Total	62.			
Calculated F Value		12.83**	11.36**	2.36*

\* Significant (.05 level)

\*\* Highly Significant (.01 level)

Plot Size: 2-30 inch rows x 50 feet  
 Design: Randomized Complete Block with 7 entries 9 replications  
 Harvest: Yield - Entire Plot  
 % Sugar - 2-25 lb. samples per plot

Planted: September 6, 1968      Harvested: July 8, 1969  
 Cooperator: Nelson Correll, Calipatria, California

Remarks: Good test. Good uniform stand. No yellows symptoms were present at harvest; however, were reported during season.

Extracted from a test with 7 varieties.

1969 YELLOWS NURSERY VARIETY TEST

- B44 -

Variety	Description	Non-Inoculated			Inoculated		
		Gross	Tons	Sugar	Gross	Tons	Sugar
		Lb/A	/A	%	Lb/A	/A	%
USH9A	569H3 x C413	8006	41.97	9.56	5797	34.27	8.54
813H8	546H3 x 813	7573	39.64	9.50	5555	31.86	8.76
US75	F55-68 (WL 716)	6351	35.12	9.16	2957	19.61	7.42
F66-13H11	550H4 x C413	6259	35.78	8.64	4493	27.42	8.06
813H50	(705H24 x 760) x 813	5968	32.28	9.21	4176	26.95	7.74
813TH49	(716H0 x 760) x 413T	5928	32.76	9.05	4192	22.45	9.25
813TH41	(716H29 x 757) x 413T	5944	34.69	8.51	3471	23.99	7.30
813H45	(705H25 x 718) x 813	5708	30.54	9.32	5584	30.78	9.05
USH9B	546H3 x C413	5589	31.75	8.81	4022	24.32	8.12
813H42	(754H4 x 704) x 813	5120	31.35	8.35	5326	31.06	8.44
813H47	(705H25 x 751) x 813	4740	27.52	8.54	5098	26.34	9.87
USH8	569H3 x NB7	4386	25.72	8.32	2837	21.13	6.79
813TH32	(754H0 x 716) x 413T	3148	22.25	7.10	4041	27.32	7.41
Test Mean		5592.	33.76	8.22	3892.	26.15	7.35
SE Mean		681.	3.67	0.48	598.	3.64	0.46
SE Mean/Test Mean (%)		12.2	10.87	5.80	15.4	13.93	6.20
LSD (5%)		1896.2	10.22	1.33	1666.0		1.27
F value		3.98**	2.36**	5.69**	2.63	ME	6.20**

\*\* Highly Significant (.01 level)

Plot Size: 1-30 inch rows x 12 feet  
 Design: Randomized Complete Block with 34 entries 4 replications  
 Harvest: Yield - Entire Plot Sugar - 2-25 lb. samples per plot  
 Planted: May 15, 1969 Harvested: October 20-22, 1969  
 Cooperator: Reclaimed Island Land Co., Tracy, California  
 Remarks: Fair test. Good - fair stand. Inoculated with virus yellows July 2. Some plants appeared to be missed.

Extracted from a test of 34 varieties

1969 TRACY BOLTING NURSERY

Planted: October 8, 1968

4 Reps

Plots: 1 (30") row x 25'

Variety	Description	May 16		June 18	
		%	Level*	%	Level*
F57-68	US75 (1957 Seed)	11	1.8	23	2.3
868	US75 (1968 Seed)	23	1.9	41	3.4
Ch13	5th YRS US75	3	0.8	9	2.6
F66-13	Inc. Ch13	8	1.0	13	2.5
F67-13	Inc. Ch13	8	1.5	19	2.1
F68-13 (413)	Inc. F66-13	5	1.1	15	2.6
F68-13 (613)	Inc. 613	7	2.0	17	3.4
C713	7th YRS US75	0	0.0	2	1.9
813T (Spence)	Ch13 Tetra	3	0.8	9	1.5
544	330 x 234	26	1.1	54	2.5
264	NB663	38	1.6	58	3.0
F62-63T	663 Tetra	16	1.8	28	2.9
USH6	664H2	12	0.8	30	2.9
USH7	664H4	4	0.4	19	2.3
USH7A	464H8	12	1.4	26	3.0
USH8	4539H4	5	1.0	17	2.4
USH9B	U713H8	9	0.9	17	2.8
USH9A	U713H4	3	1.3	12	2.1
613H4	569H3 x 613	1	0.1	10	2.0
713H4	569H3 x 713	1	0.4	12	2.6
813H8	546H3 x 813	1	0.4	5	2.0
813H42	(754H4 x 704) x 813	4	0.5	25	2.5
813H44	(705H24 x 714) x 813	16	1.4	31	3.6
813H45	(705H25 x 718) x 813	9	1.0	18	3.0
813H46 (M-)	(716H29 x 718) x 813	6	1.3	11	2.8
813H47	(705H25 x 751) x 813	8	1.4	14	2.6
813H48	(716H29 x 734) x 813	19	1.3	39	2.9
813H50	(705H24 x 705) x 813	2	0.9	14	2.6
813TH32	(754H0 x 716) x 413T	5	1.1	8	2.6
813TH41	(716H29 x 757) x 413T	7	1.3	10	3.0
813TH49	(916H0 x 760) x 413T	0	0.0	6	2.3
813H32A	(754H0 x 716) x 413	9	1.9	19	2.3
813H41A	(716H29 x 757) x 413	24	1.9	41	2.8
813H49A	(716H0 x 760) x 413	17	1.3	35	3.3
Y803H4	569H3 x 803	11	1.3	40	3.1
Y804H8	546H3 x 804	11	1.5	32	2.5
868H4	569H3 x 868	7	1.1	13	2.9
F59-512H1	NB5 x NB6	1	0.5	2	1.0
F66-546H3	562H0 x 546	2	0.8	10	2.1
F66-569H3	562H0 x 569	1	0.3	7	1.4
F66-550H4	563H0 x 550	1	0.6	3	1.8
F59-512	NB6	0	0.0	0	0.0
F59-502H0	NB1MS	0	0.0	24	1.4
O539	NB7	0	0.0	25	1.4
F66-562	Inbred	1	0.3	7	1.4
F66-562H0	Inbred	0	0.0	6	2.1
F64-550	Inbred	0	0.0	5	1.3
F67-563	Inbred	0	0.0	0	0.0
F67-563H0	Inbred	0	0.0	1	0.5
F67-564	Inbred	2	0.5	9	0.9
F67-564H0	Inbred	2	0.4	5	0.9

\*Level denotes approximate general height (feet) of bolters present.



DATA ON U.S.D.A. VARIETIES TESTED BY SPRECKELS SUGAR COMPANY - 1969

TEST AREAS:

Variety	SPRECKELS			SPRECKELS			KING CITY			SANTA MARIA		
	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar
US H9A	2.187	17.88	12.4				4.987	33.37	15.1	3.012	30.58	9.8
US H9B	1.966	16.24	12.3	2.775	19.80	14.2	4.130	27.39	15.3	3.048	31.44	9.7
US H7A	1.519	11.47	13.5	2.336	15.74	15.1	3.977	25.92	15.5	3.002	30.22	9.9
263TH4				2.457	16.58	15.0						

GENERAL MEAN

GENERAL MEAN	1.584	12.53	12.9	2.477	16.70	15.0	4.304	28.03	15.5	3.022	31.14	9.7
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LSD @ P=.05

LSD @ P=.05	1.735	6.02	NS	NS	NS	0.57	NS	NS	0.63	0.422	3.69	NS
LSD @ P=.01	2.315	6.70	NS	NS	NS	0.75	NS	NS	0.84	0.563	4.93	NS

S E of Mean

S E of Mean	0.193	1.765	0.422	0.203	1.38	0.20	0.345	2.26	0.22	0.148	1.300	0.213
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SE % of Mean

SE % of Mean	10.00	14.09	3.27	8.20	8.23	1.35	8.02	8.06	1.42	4.89	4.17	2.20
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# Var.in Test

# Var.in Test	8	8		16	8		8			8		
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Planting Date

Planting Date	March 4, 1969	March 17, 1969		March 17, 1969	March 8, 1969		March 8, 1969			March 15, 1969		
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Harvest Date

Harvest Date	Sept. 11, 1969	Sept. 15, 1969		Sept. 15, 1969	October 29, 1969		October 29, 1969			Sept. 30, 1969		
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DATA ON U.S.D.A. VARIETIES TESTED BY SPRECKELS SUGAR COMPANY-1969 Con't.

TEST AREAS:	COLLEGEVILLE			WOODLAND			MENDOTA			PHOENIX, ARIZONA		
	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar
US H9A	5.090	30.32	16.8	3.956	33.72	11.7	4.340	32.62	13.4	4.06	26.7	15.3
US H9B	4.886	29.36	16.7	4.439	36.32	12.3	3.640	28.73	12.7	4.50	28.9	15.6
US H7				3.998	33.65	11.9	3.580	26.68	13.5			
US H8				3.618	29.92	12.1				3.00	20.2	15.1
713H4				4.531	37.66	12.0	3.750	28.62	13.1			
713H29				3.319	31.36	10.6						
713H35				2.981	27.90	10.7						
744H4				4.329	37.92	11.4						
744H8				4.331	36.64	11.9						
767H4				4.175	31.66	13.2						
30TH33				3.158	27.12	11.7						
813H-50							4.140	30.62	13.5			
813H-8							4.130	30.92	13.4			
813H-45							3.690	26.90	13.7			
813H-47							3.630	27.34	13.3			
813T-49							3.620	26.95	13.6			
813T-32							3.450	28.16	12.3			
813T-41							3.450	28.16	12.3			
813T-42							3.280	27.10	12.2			
US H7A							3.930	30.01	13.2			
GENERAL MEAN	4.584	27.35	16.8	3.931	33.15	11.9	3.770	28.76	13.1	3.499	23.05	15.2
LSD @ P=.05	0.548	3.08	0.54	0.493	4.04	0.78	0.54	4.07	0.94	0.432	2.92	NS
LSD @ P=.01	0.732	4.11	0.73	0.654	5.36	1.03	0.72	5.40	NS	0.576	3.90	NS
SE of Mean	0.193	1.084	0.19	0.175	1.435	0.276	0.19	1.45	0.33	0.152	1.030	0.225
SE % of Mean	4.21	3.96	1.14	4.44	4.32	2.32	5.10	5.02	2.54	4.34	4.47	1.48
# Var.in Test		8			16			16			8	
Planting Date	May 8, 1969			May 16, 1968			April 24, 1969			September 16, 1968		
Harvest Date	November 11, 1969			May 5, 1969			October 8, 1969			June 27, 1969		

VARIETY TEST, SALINAS, CALIFORNIA, 1969

(10 replications of each variety) By Union Sugar Division

Variety	Description	Acre Yield		Sucrose Percent	Harvest Count
		Sugar Pounds	Beets Tons		
813H44	(705H24 x 714) x 713A	11,230	32.71	17.2	104
813H45	(705H25 x 718) x 713A	11,190	32.75	17.1	104
813TH40	(754H0 x 760) x 713T	11,130	32.94	16.9	108
813H50	(705H24 x 705) x 713A	11,100	31.78	17.5	114
F66-13H11	(563H0 x 550) x 413	10,990	33.32	16.5	109
813H47	(705H25 x 751) x 713A	10,850	31.44	17.3	113
813TH32	(754H0 x 716) x 713T	10,800	32.83	16.5	104
813TH41	(716H29 x 757) x 713T	10,680	32.03	16.7	100
813H46	(716H29 x 718) x 713A	10,580	31.08	17.1	102
813H42	(754H4 x 704) x 713A	10,490	30.71	17.1	101
813H8	546H3 x 713A	10,450	30.53	17.1	110
U813H8	US H9B	10,340	30.31	17.1	123
U813H4	US H9A	10,210	30.55	16.7	114
664H8	US H7A	9,960	28.22	17.7	112
664H4	US H7	9,940	28.42	17.5	109
868H4	569H3 x 868	9,690	28.06	17.3	114
Mean		10,600	31.11	17.1	Beets
LSD (.05)		587	1.78	0.45	per
Coefficient of Variation		6.25	6.47	2.94	100'
F value		5.26**	7.28**	4.71**	row

\*\*Exceeds the 1% point of significance (F=2.18)

Remarks: A yield test of 16 varieties in a randomized block design was included in a 42.8 acre field of sugarbeets on the Elmer Abeloe Ranch, Salinas, California. Plots 60 feet long were planted on double-row beds with 40-inch centers. Beds were fumigated with 10 gallons per acre of Vidden D to control scattered sugarbeet nematode infestations. A preplant herbicide treatment of 52 ounces of Tillam in 45 gallons of water per acre was incorporated in 22-inch wide strips on the beds. The test plot was planted April 14 and thinned May 17, 1969. A post-emergence application of Pyramin 80 W at three pounds per acre plus summer oil at two quarts per acre was made on May 31, 1969, when plants were at the 4 leaf stage of growth. The field was sprayed with Metasystox R on May 14, 1969 for control of green peach aphid. Sprinkler irrigations, at 10-day intervals, were started about May 1, 1969. The total fertilizer used consisted of 245 lbs. of actual N and 203 lbs. of P, as P<sub>2</sub>O<sub>5</sub>, applied by preplant, one sidedress application, and through the sprinkler system. The test plot was harvested October 8-9, 1969. Sugar analyses were made at the United States Agricultural Research Station, Salinas, California. Test design, seed, and analysis of results were supplied by the U.S. Research Station.

Virus diseases were minor and no nematode damage was evident throughout the field. The herbicide applications provided excellent weed control throughout the growing season. Heavy weed populations existed only at the ends of rows. The field was space planted with a 5 1/4 inch spacing between seeds which produced an excellent stand of beets. The field yielded 26.87 Tons per acre with 16.58 percent sucrose.

VARIETY TEST, EL CENTRO, CALIFORNIA, 1969  
Lerno Bros. Ranch

(8 replications of each variety)

By Union Sugar Division

Variety	Description	Acre Yield		Sucrose Percent	Harvest Count Number
		Sugar Pounds	Beets Tons		
813TH49	(716H0 x 760) x 713T	9,690	29.64	16.34	258
U713H8	US H9B	9,260	28.38	16.31	284
813H47	(705H25 x 751) x 713A	9,020	28.16	16.01	267
813H50	(705H24 x 705) x 713A	8,960	27.57	16.27	291
U713H4	US H9A	8,630	26.70	16.19	289
664H4	US H7	7,690	24.80	15.51	275
Mean		8,880	27.54	16.11	Beets
LSD (.05)		936	2.92	0.44	per
Coefficient of Variation		3.28	10.44	0.86	100'
F value		4.33**	2.65*	4.19**	row

\*Exceeds the 5% point of significance ( $F=2.48$ )

\*\*Exceeds the 1% point of significance ( $F=3.58$ )

Remarks: A yield test of six varieties in a randomized block design was included in a 64 acre field of sugarbeets located at Evergreen Canal, gate 23-A, Lerno Bros. Ranch. Soil type was silty clay loam and previous crops were sugarbeets, 1967-68, and alfalfa, 1963-67. Plots 60 feet long were planted on double-row beds with 40-inch centers. The test was planted October 20, 1968 and thinned December 3, 1968. A spray application of Methyl parathion at one lb. per acre controlled desert flea beetle and striped cucumber beetle. Curly top infection was minor. The field received 12 irrigations by furrow and 1.20 inches rainfall during the growing season. Fertilizer use totaled 280 lbs. per acre N and 60 lbs. per acre actual P applied preplant, and in one sidedress application following thinning. Symptoms of a moderate virus yellows infection were observed about April 1, 1969. The test was harvested July 16, 1969.

The field in which the yield test was located yielded 22.43 T.P.A. with 15.88 percent sucrose.

Sucrose determinations were made by Union Sugar Division, Imperial Valley Tare Laboratory, El Centro, California. Experimental design and seed supplied by U.S. Agricultural Research Station, Salinas, California. Tests were planted, observed throughout season, and harvested by K. D. Beatty, Southwestern Irrigation Field Station, Brawley, California, in cooperation with Union Sugar Division. Results analyzed by K. D. Beatty.



VARIETY TEST, CALIPATRIA, CALIFORNIA, 1969  
Andy Schunk Ranch

(8 replications of each variety)

By Union Sugar Division

Variety	Description	Acre Yield		Sucrose Percent	Harvest Count Number
		Sugar Pounds	Beets Tons		
813TH49	(716H0 x 760) x 713T	14,330	42.69	16.79	272
813H50	(705H24 x 705) x 713A	13,060	40.68	16.06	290
813H47	(705H25 x 751) x 713A	12,590	38.74	16.25	264
U713H8	US H9B	12,130	37.76	16.08	280
U713H4	US H9A	12,060	38.26	15.81	292
664H4	US H7	9,320	30.01	15.53	288
Mean		12,250	38.02	16.09	Beets
LSD (.05)		1,200	3.69	0.32	per
Coefficient of Variation		9.68	9.55	1.96	100'
F value		15.62**	11.38**	14.63**	row

\*\*Exceeds the 1% level of significance (F=3.61)

Remarks: A yield test of six varieties in randomized block design was included in a 64 acre field of sugarbeets located at Vail Canal 3A, gate 362, Andy Schunk Ranch. Soil type was silty clay and previous crops were grain sorghum, 1968 and sugarbeets, 1965-67. Plots 60 feet long were planted on double-row beds with 40-inch centers. The test was planted September 16 and thinned October 2, 1968. Parathion was applied for control of desert flea beetle and striped cabbage beetle. The field received 13 irrigations by furrow and 1.20 inches rainfall during the growing season. Fertilizer was totaled 250 lbs. per acre N applied preplant and following thinning. Symptoms of a moderate virus yellows infection were observed about April 1, 1969. Close cultivation necessitated by a severe weed infestation resulted in stand losses in the test plot. A topical application of IPC granules for grass control was ineffective. Due to the stand losses only 10-foot sections of each plot were harvested. The test was harvested July 18, 1969.

Sucrose determinations were made by Union Sugar Division, Imperial Valley Tare Laboratory, El Centro, California. Experimental design and seed supplied by U.S. Agricultural Research Station, Salinas, California. Tests were planted, observed throughout season, and harvested by K. D. Beatty, Southwestern Irrigation Field Station, Brawley, California, in cooperation with Union Sugar Division. Results analyzed by K. D. Beatty.

SELECTION AND EVALUATION OF YELLOWS RESISTANCE  
AT SALINAS, CALIFORNIA, 1969

R. T. Levellen, I. O. Skoyen, and J. S. McFarlane

Self-sterile and Hybrid Varieties.---Four self-sterile lines were selected for yellows resistance at Salinas in 1969. A continuing effort is being made to select yellows resistance from unrelated self-sterile lines and to increase the yellows resistance of a potential topcross parent. Of the self-sterile lines evaluated in 1969, Y801, a composite of 12 or 13 lines, is showing promise as an additional source of resistance.

There was a higher incidence of bolting than usual in early planted fields in 1969, and the roots of bolted beets tended to be tough and difficult to slice. From the November planted bolting tests, a bolting selection was made within the yellows resistant line 13. The nonbolted roots were then reselected for ease of slicing and percent sucrose.

Four yellows-resistant, self-sterile lines, 713A, Y704, Y603, and 610, were indexed and selected for type 0. The increase from at least three of these lines will need to be reselected because too few plants segregated completely for type 0.

Many self-sterile lines selected for yellows resistance were evaluated either individually or as topcross parents in three-way hybrids. In addition to the Salinas bolting and varietal trials, the Brawley and cooperative tests with the California companies were used for evaluating resistant material. The performance of these variety trials have already been presented in this report. In its first year of testing, the 813 line showed better overall performance as a topcross parent than its related 413 line both for combining ability and yellows resistance.

One set of four variety trials at Salinas was treated nearly identically, except one test was inoculated with BYV-BMYV while the other three tests were not. Comparisons were made between the varieties in common between the inoculated test and the three noninoculated tests. The table shows the effects of yellows infection under Salinas conditions for these varieties. The performance data from which this table was constructed are presented in the Salinas varietal trial summaries.

Self-fertile Lines.---The development of yellows-resistant self-fertile lines of sugarbeet is a primary goal. Selections for yellows resistance were made within eight self-fertile lines in 1969. Three other monogerm lines with some yellows resistance were indexed and selected for type 0. In addition to yellows resistance, selected lines should have good combining ability for average yield, curly top resistance, bolting resistance, and monogerm seed.



A yellows-resistant evaluation test composed of 44 monogerm and multigerm self-fertile lines was grown at Salinas. The test included inoculated and noninoculated duplicate plantings with four replications each. Plots were 30 feet long and 28 inches wide. The inoculation was made with a combination of BYV and BWV when the plants were in the 6 to 10-leaf stage. The resistance to yellows as measured by sucrose and yield loss and the general performance of these lines under both virus treatments are given in tabular form. The results of this test show that the best lines are still multigerm, e.g., 7704, 7734, 7760, 4716, 5723, and 7757, while there is only one monogerm line, i.e., 7705, with nearly equal performance. The monogerm lines, 5725 and 6709, have not shown this degree of resistance in other tests.

The performance of hybrids with several of these self-fertile lines as components was evaluated in the Salinas bolting and yield tests, the Brawley tests, the Davis tests, and the cooperative company tests. The performance of these varieties is summarized in tabular form throughout this report. At Salinas, Davis, and Brawley, where moderate to severe yellows infection occurred either through inoculation or natural means, the hybrids with two or more components selected for yellows resistance generally performed better than hybrids with no or only one component selected for yellows resistance. However, even under conditions where yellows was not a serious consideration, varieties with two or more yellows resistant components generally performed equal to or better than the standard yellows resistant hybrid, US H9, and the standard susceptible hybrid, US H7.

These results indicated that some self-fertile lines selected for yellows resistance have at least equal combining ability to presently used inbreds when used as components in the F<sub>1</sub> parent of 3-way hybrids. However, most of these lines still have one or more major deficiencies, e.g., they are multigerm, curly top susceptible, lack bolting resistance, etc. Because of these deficiencies, continued emphasis is needed to produce yellows resistant hybrids for commercial use that are superior to those developed by using only a yellows resistant topcross parent. The 1969 test results were encouraging and demonstrated that greater yellows resistance is possible through the use of yellows resistant inbreds.

The development of the best self-fertile lines with yellows resistance will be continued, and where possible, selections will be made for necessary characteristics. However, the best approach at this time appears to be the development of new lines. Currently, this is the direction of a major portion of the yellows breeding program. Using the most yellows resistant inbreds, which are mostly multigerm, and yellows selected monogerm lines with desirable features, an extensive crossing program was initiated in 1968 and 1969. Some of these crosses were between only two lines, e.g., multigerm, yellows resistance x monogerm, curly top resistance, bolting resistance, and type 0, but most were crosses that will be composited which included the major characteristics from several of the best available sources. From these crosses and composites, various breeding schemes will be used to develop self-fertile lines adapted to commercial needs.

Effect of BYV-BWV infection on yield and sucrose percentage  
of sugarbeet varieties at Salinas, California, 1969

Variety	Reduction in yield and sucrose			Variety	Reduction in yield and sucrose		
	Sugar	Beets	Sucrose		Sugar	Beets	Sucrose
	Percent	Percent	Pct. pts.		Percent	Percent	Pct. pts.
Inoculated vs. one-row variety trial							
813	10.7	10.7	0.0	813H45	26.6	19.2	1.6
Y803	12.8	10.6	0.4	813H50	28.8	24.2	1.0
814	14.9	12.3	0.5	813H8	29.0	26.5	0.6
713B	15.4	13.3	0.3	813H48	29.9	24.5	1.2
713H39	16.5	15.1	0.2	813H44	30.4	22.8	1.7
Y804	17.1	14.2	0.5	813H46	30.6	27.5	0.7
713H30	17.7	14.5	0.6	813H42	30.7	25.9	1.1
F68-613	18.0	19.0	-0.2	Y803H4	32.5	27.9	1.1
813T	18.6	14.9	0.7	713H4	33.8	28.0	1.4
F68-413	18.8	19.2	-0.1	813H47	34.3	28.3	1.5
713	19.2	16.8	0.5	F66-13H11	35.1	30.8	1.0
Y801	21.5	21.0	0.2	U813H4	36.4	32.0	1.1
Y601	22.6	22.8	-0.1	U813H8	36.5	32.4	1.0
730T	24.8	21.7	0.6	613H4	36.9	32.8	1.0
713H38	24.9	23.4	0.3	Y804H8	45.9	41.0	1.4
F66-64	29.8	27.6	0.5	664H4	46.7	40.1	1.9
868	33.4	31.3	0.5	868H4	48.7	42.2	1.9
Y802	43.6	39.5	1.1				
Inoculated vs. diploid-triploid comparison							
				813TH41	27.5	24.2	0.8
				813TH32	31.7	27.0	1.0
				813TH40	33.4	26.4	1.6
				813TH49	33.6	27.4	1.5

Note: The above data were obtained by comparing varietal performances from four adjoining tests that were planted and harvested at nearly the same time. The performance data and descriptions for these varieties were given previously in this report. A single test was inoculated with BYV-BWV and the three other tests were sprayed with Meta-systox. Natural infection occurred later than normal but probably caused some yield loss in the noninoculated tests. Even though the above data can not be treated statistically, we feel that within each test they give a good relative indication of varietal reaction to yellows infection under conditions of the Salinas tests.



**Planted:** April 12, 1969

Inoculated: May 27, 1969

Harvested: October 2, 1969

Variety	Description	Gross Sucrose/A		Tons Roots/A		% Pts.		Inoc.
		Check	Inoc.	Check	Inoc.	Check	Inoc.	
<b>Monogerm</b>								
5725	3 YRS S6(SLC 122-0aa x 6515C1)	5,620	3,830	32.0	16.73	12.39	15.5	1.37
6709	S3(C817 x 1711C2mm)	3,960	2,620	33.7	11.20	8.01	16.4	1.33
7705A	YRS S3(121R x 2743C2)	5,630	3,560	36.8	16.03	11.23	15.9	1.73
7724	2 YRS S2(321R x 2764C1)	4,090	2,410	41.0	12.56	8.26	14.6	1.67
7722M	S2(330R x 3563-1)	5,650	3,120	44.7	18.09	10.71	14.6	1.03
5764	YRS (2711C1, 2763C1, 2764C1)	5,550	3,060	44.9	17.18	10.50	14.5	1.68
5743A	3 YRS S3(928-20 x 9561-3mm)	5,050	2,650	47.6	14.17	8.43	15.7	2.10
6707	S3(121R x 2546-22-35)	5,450	2,810	48.5	17.29	9.34	15.8	0.82
F66-546	Inc. F63-546	6,460	3,300	48.9	18.41	10.74	15.4	2.15
5715	3 YRS S7(4651mm x 5570-49-4C1)	5,730	2,760	51.9	17.64	8.92	15.4	0.83
7702	2 YRS S3(121 x 2563)	4,710	2,240	52.5	13.82	7.70	14.6	2.45
6746	S2(2563 x 3763)	4,530	2,150	52.6	13.65	7.21	15.0	1.58
7735	S2(541 x 4714C1mm)	3,630	1,670	54.0	11.23	5.77	14.4	1.73
7718	S4(2563 x 1716-6C2)	5,290	2,410	54.5	16.20	8.47	14.2	2.10
7701	YRS S3(121 x 1711C2)	4,720	2,130	54.9	14.49	7.49	14.2	2.08
7714	S4(2563 x 2743C2mm)	3,970	1,740	56.2	11.83	5.84	14.9	1.92
F66-569	Inc. F59-569	6,000	2,500	58.3	17.78	8.19	15.3	1.60
6744	S2(121R x 3711-3)	5,160	2,150	58.4	15.89	7.35	14.6	1.63
F66-562HO	MS of 562	5,970	2,480	58.5	17.43	8.29	15.1	2.10
4522	Inc. CTR S1(8546-7 x 8561-16)	4,300	1,660	61.3	14.14	6.02	13.8	1.40
8740	S3(421B x 4702)	5,070	1,700	66.4	16.03	6.23	13.7	2.10
7751	S3(2563 x 3716-18)	6,260	2,050	67.2	18.90	7.14	14.4	2.20
<b>Multigerm</b>								
7704	2 YRS S3(121 x 1716-6C2)	6,970	4,850	30.5	20.40	15.36	15.8	1.33
7734	2 YRS S5(927-35 x 5577-2)	9,130	5,800	36.5	27.89	18.48	15.7	0.67
7760C2	Type 0 5760	6,570	4,090	37.7	19.49	13.02	15.7	1.17
4716-18A	2 YRS S8(062-3 x B25-9)	7,010	4,340	38.0	22.50	15.33	14.3	1.30
5723	S1(NBlaa x 234)	7,970	4,930	38.2	23.73	15.57	15.9	0.97

Performance of self-fertile lines and reduction in yield under BYV-BWV inoculated and noninoculated treatments at Salinas, California, 1969 (continued).

(Duplicate tests)  
(4 replications of each variety per treatment)  
(Single-row plots)

Planted: April 12, 1969  
Inoculated: May 27, 1969  
Harvested: October 2, 1969

Variety	Description	Gross Sucrose/A		Loss %	Tons Roots/A		% Sucrose		% Pts.	
		Check	Inoc.		Check	Inoc.	Check	Inoc.	Check	Inoc.
5760	2 YRS S <sub>4</sub> (911 spec. x 9717-4)	6,970	4,270	38.7	20.72	13.62	16.9	15.7	1.20	4.8
7757	2 YRS S <sub>5</sub> (911 spec. x 9716-4)	7,290	4,420	39.4	23.80	14.98	15.3	14.8	0.55	5.0
4716-18B	2 YRS S <sub>9</sub> (062-3 x B25-9)	7,290	4,310	40.9	22.68	14.35	16.1	15.0	1.05	5.5
5768	1 YRS S <sub>4</sub> (926-36 x 9716-8)	7,820	4,540	42.0	22.64	14.38	17.3	15.8	1.50	5.8
7703	2 YRS S <sub>3</sub> (121R x 8539)	6,540	3,680	43.7	22.05	13.02	14.9	14.1	0.73	6.3
8748	Inc. Acc. 106 from Powers	5,240	2,700	48.5	14.84	8.50	17.7	15.9	1.80	8.0
7754	3 YRS S <sub>5</sub> (671-22 x 9716-10)	6,440	3,220	50.0	19.81	11.34	16.3	14.2	2.07	6.0
7753	3 YRS S <sub>5</sub> (YRS 671 x 9716-4)	6,180	2,920	52.7	19.67	10.18	15.8	14.3	1.43	6.3
0539	NB7	6,240	2,780	55.5	20.37	9.55	15.3	14.5	0.80	7.5
7716	3 YRS S <sub>10</sub> (062-3 x B25-9)	6,660	2,760	58.6	21.91	9.76	15.2	14.1	1.10	6.5
7756	S <sub>2</sub> (541 x 5702)	6,740	2,690	60.1	19.74	8.47	17.0	15.9	1.12	7.8
F56-511	NB2	7,340	2,860	61.0	22.15	9.59	16.6	14.9	1.63	7.5
F59-502HO	MS of null	7,080	2,580	63.5	21.49	8.75	16.5	14.7	1.74	7.8
Inoculated Test										
6727C2	S <sub>2</sub> (121rr x 2763C1)	--	2,290	--	--	7.98	--	14.3	--	6.8
5731	YRS S <sub>5</sub> (585 x SLC 122-0)	--	2,660	--	--	8.61	--	15.5	--	7.0
4742	3 YRS S <sub>3</sub> (928-9x502)	--	2,780	--	--	9.17	--	15.2	--	6.3
5745C1	S <sub>1</sub> (321 x 3711-3)	--	3,920	--	--	12.67	--	15.5	--	6.5
Mean		5,960	3,050	48.7	18.17	10.16	16.5	15.0	1.48	6.5
LSD (.05)		925	613	--	2.81	2.05	0.77	0.66	--	0.86
Coefficient of Variation		11.09	14.34	--	11.03	14.37	3.35	3.14	--	9.36
F value		13.80**	20.05**	--	14.96**	17.60**	7.45**	8.03**	--	9.41**

Check \*\*\*Exceeds the 1% point of significance (F=1.79)  
Inoc. \*\*\*Exceeds the 1% point of significance (F=1.74)

1/ Foliar symptoms for the inoculated plots were based on a scale from 0 to 9. As the scale increases, the severity of yellowing and stunting increases.

# EVALUATION OF YELLOWS RESISTANCE AT DAVIS, CALIFORNIA, 1969<sup>1/</sup>

R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane

Location: Agronomy Farm ~~area~~ B-3, University of California.

Planting date: May 22, 1969.

Inoculation date: July 10, 1969. Three populations of aphids were produced at Salinas for inoculating at Davis. Inoculations were made with strain 7 of BYV, a combination of strains of BWYV, and both of these viruses together.

Irrigations: Starting May 26, 1969 at 10-12 day intervals.

Harvest dates: October 20-23, 1969.

Diseases and insects: Emergence occurred after most aphid flights had ceased. By August 6 yellows infection was evident in all inoculated strips except where BWYV was used alone. There were few escapes in the BYV-BWYV and BYV inoculated strips and few plants showed yellows in the noninoculated strips. By August 26 about five percent of the plants in the noninoculated strips showed mosaic or yellows symptoms, and at harvest these viruses were prevalent. There was a high incidence of root rot throughout the tests, but rotting was particularly evident in some plots. The primary rotting organism was not determined, but rhizoctonia was probably involved. Army worms were prevalent throughout the season.

Experimental design: The plot field was divided into three tests. The first test was composed of 16 self-sterile varieties. The second test had 19 hybrid varieties. These two tests were randomized block designs with five replications divided into inoculated and noninoculated treatments. A combination of BYV and BWYV was used as inoculum. The subplots were 40 feet long and two 30-inch rows wide. The plants were thinned to an 8 to 10-inch stand. The third test was composed of 6 self-sterile and 4 F<sub>1</sub> hybrid varieties. Each of the five replications was divided into three virus treatments: noninoculated, inoculated with only BYV, and inoculated with only BWYV. The subplots were 25 feet long and two 30-inch rows wide.

<sup>1/</sup> The assistance of Dr. F. J. Hills of the University of California in arranging for the Davis tests is gratefully acknowledged.



Yield and sucrose determinations: These tests were topped and lifted by machine and field weights were taken by hand. From every subplot two 8 to 10-beet samples were randomly selected and sucrose percent was determined at the U.S. Agricultural Research Station, Salinas, California. Stands were good for most plots, but where skips occurred the paired subplots were mechanically adjusted and then readjusted to whole plot values for yield analyses. Plots were generally not adjusted for missing feet of row caused by root rot nor were partially rotted beets selected for sucrose analysis. Resistance was measured by comparing each paired inoculated and noninoculated subplot and determining the percent loss due to yellows.

Self-sterile Variety Test.--The performance of the 16 self-sterile varieties is summarized in tabular form. Seven of the entries were lines selected from UE 75 for yellows resistance. (See the table on the year of production and pedigree of the variety 13.) The more recent selections, e.g., 713B, 713, and 813, appear to have greater yellows resistance than the earlier selections, e.g., 413A and F68-413. The composite Y801 showed greater resistance than its unselected parent, Y601. Although healthy Zwaanpoly was the highest yielding variety in this test, it was quite susceptible to yellows.

Hybrid Variety Test.--The performance of the 19 hybrid varieties tested at Davis are given in tabular form. In general, the hybrids with two or more components selected for yellows resistance, e.g., 813H42, 813H50, 813TH49, etc., showed the least loss from yellows infection, while those with no selected component, e.g., 664H4 and 868H4, showed the greatest loss. The hybrids with only the topcross parent selected for yellows resistance, e.g., 813H8, Y804H8, UE H9A, UE H9B, etc., were generally intermediate.

Relative Varietal Resistance to BYV and BWYV.--BYV and BWYV are two distinct viruses. Therefore, the inheritance of resistance to one is probably independent of the other. BYV is generally more severe than BWYV, but it is not as common and can be more easily controlled by beet free periods. It is important then to have resistance to both. Selections for yellows resistance have been made at Salinas in populations of space planted beets infected with a combination of BYV and BWYV. Because our evaluation tests for yellows resistance have also employed a combination of both viruses, the specific resistance to either BYV or BWYV is unknown. The results of a 1969 test at Davis designed to evaluate the resistance of 10 varieties to either BYV or BWYV is presented in tabular form in this report.

By August 6 the BYV inoculated treatment showed definite yellows infection similar to the varieties in the BYV-BWYV inoculated test. However, the BWYV inoculated treatment had essentially no symptoms throughout the season. The only exception was 868 which showed slight yellowing and thickening of the older leaf blades. The yield data



show that these varieties were probably infected. After the Davis inoculations, 12-15 sugarbeet plants were randomly saved from each of the populations used to produce the viruliferous aphids. Reinoculations by aphids from these plants to sugarbeet, shepherd's purse, and Chenopodium capitatum were made. The responses of these differential hosts indicated that the desired virus(es) were present without contamination.

Even though the soil was wet, in the afternoons the tops of the beets wilted. It was observed that within each set of virus treatments, the greatest wilting occurred in the healthy varieties and the least in the BYV infected varieties. The difference probably reflected a decrease in leaf canopy of infected plants and their thickened, more rigid leaf structure.

Y803 had poor stands in this test resulting from poor emergence. This caused the plant numbers to be somewhat irregular between treatments within the same replication. In several varieties there was considerable root rot. In addition, the virus treatment appeared to influence the amount of rotting detected within a replication.

The table shows that gross sugar losses caused by BWYV varied from 0% to 21.7%, while the losses caused by BYV varied from 13.8% to 41.4%. For the varieties in common between this test and the self-sterile variety test there is good agreement for yield between the noninoculated treatments and percent loss between the BYV and BYV-BWYV treatments. In general, varietal losses caused by BWYV were about one-half of those caused by BYV.

Similar tests will be continued at Salinas and Davis to further clarify the relative influence of BYV and BWYV infections on resistant and susceptible genotypes.

Performance of self-sterile sugarbeet lines and reduction in yield under BYV-BMYV inoculated and noninoculated treatments at Davis, California, 1969.

(5 replications of each variety)  
(Two-row plots)  
(Split-block design)

Planted: May 22, 1969  
Inoculated: July 10, 1969  
Harvested: October 21, 1969

Variety	Description	Gross		Tons Roots/A		Yield	
		Gross Sucrose/A	Suc. Loss	Check	Inoc.	Loss	Percent
		Check	Percent	Check	Inoc.	Percent	
713B	8 YRS US 75	8,340	14.0	32.68	29.78	9.0	
F68-613	Inc. 7 YRS US 75	8,650	16.0	33.13	29.77	10.0	
713	Inc. 7 YRS, 1 SS US 75	7,340	17.0	27.71	24.33	12.0	
Y804	Inc. (YRS 534 x YRS 413)	9,250	18.0	34.90	32.29	7.0	
Y801	YRS Y601	10,630	23.0	39.56	33.51	15.0	
813	Inc. 8 YRS, 2 SS US 75	8,750	24.0	32.28	25.95	19.0	
Y803	Inc. Y603	9,660	25.0	35.42	28.21	20.0	
813T	Inc. 713T	7,940	27.0	32.82	25.58	22.0	
Y601	Inc. Y501	10,630	27.0	39.06	32.31	17.0	
814	Imperial V. Sel. 713	8,440	30.0	31.76	25.70	18.0	
413A	6 YRS US 75	9,590	31.0	36.72	27.98	24.0	
F68-413	Inc. 5 YRS US 75	8,520	31.0	32.67	25.00	24.0	
Zwaanpoly							
911C2	3 YRS US 75	10,870	37.0	42.24	31.72	25.0	
868	Inc. F57-68 (US 75)	9,570	39.0	34.22	24.71	28.0	
F66-64	BRS 663	9,160	41.0	35.25	24.08	32.0	
		9,630	42.0	36.20	23.81	34.0	
Mean		9,190	28.0	34.79	27.79	20.0	
LSD (.05)		864	9.3	3.27	3.05	8.1	
Coefficient of Variation		7.43	26.25	7.44	8.67	32.47	
F value		10.66**	7.54**	9.17**	9.67**	7.70**	

\*\*Exceeds the 1% point of significance (F=2.36)

Performance of self-sterile sugarbeet lines and reduction in yield under  
BYV-BWV inoculated and noninoculated treatments at Davis, California, 1969 (continued).

(5 replications of each variety)  
(Two-row plots)  
(Split-block design)

Planted: May 22, 1969  
Inoculated: July 10, 1969  
Harvested: October 21, 1969

Variety	Description	Sucrose Percent		Sucrose Loss		No. Rotted	
		Check	Inoc.	Check	Pct. pts.	Check	Inoc.
713B	8 YRS US 75	12.8	12.0	0.81		9.0	8.2
F68-613	Inc. 7 YRS US 75	13.0	12.1	0.95		10.0	8.4
713	Inc. 7 YRS, 1 SS US 75	13.2	12.4	0.82		11.2	8.4
Y804	Inc. (YRS 534 x YRS 413)	13.3	11.7	1.57		4.2	1.8
Y801	YRS Y601	13.5	12.2	1.32		0.8	1.4
813	Inc. 8 YRS, 2 SS US 75	13.6	12.7	0.91		6.8	10.0
Y803	Inc. Y603	13.7	12.9	0.78		0.8	0.8
813T	Inc. 713T	12.1	11.4	0.74		7.8	13.4
Y601	Inc. Y501	13.6	12.0	1.60		1.6	1.6
814	Imperial v. Sel. 713	13.3	11.4	1.87		9.0	8.4
413A	6 YRS US 75	13.1	11.9	1.20		0.6	2.4
F68-413	Inc. 5 YRS US 75	13.0	11.7	1.31		6.0	6.0
Zwaanpoly							
911C2	3 YRS US 75	12.9	10.8	2.11		0.8	1.8
868	Inc. F57-68 (US 75)	14.0	11.7	2.26		1.2	1.0
F66-64	BRS 663	13.0	11.2	1.76		1.0	0.4
		13.4	11.7	1.70		1.2	2.0
Mean		13.2	11.8	1.36		4.5	4.8
LSD (.05)		0.65	0.59	--		4.58	3.33
Coefficient of Variation		3.91	3.90	--		80.40	55.41
F value		3.55**	6.68**	--		5.93**	12.32**

\*\*Exceeds the 1% point of significance ( $F=2.36$ )

Performance of hybrid sugarbeet varieties and reduction in yield under BYV-BWV inoculated and noninoculated treatments at Davis, California, 1969.

Planted: May 22, 1969 Inoculated: July 10, 1969 Harvested: October 22, 1969									
Variety	Description	Gross Sucrose/A		Gross		Tons Roots/A		Yield	
		Check	Inoc.	Suc. Loss Percent	Check	Inoc.	Check	Inoc.	Loss Percent
813H42	(754H4 x 704) x 713A	9,320	7,570	19.0	32.63	29.86	9.0		
813H50	(705H24 x 705) x 713A	9,650	7,760	19.0	34.24	30.77	10.0		
813TH49	(716H0 x 760) x 713T	10,260	8,210	20.0	38.20	33.23	13.0		
613H4	569H3 x 513	9,730	7,490	22.0	34.82	28.75	17.0		
813H44	(705H24 x 714) x 713A	10,120	7,770	23.0	35.54	30.72	13.0		
813H46	(716H29 x 718) x 713A	10,300	7,860	23.0	37.59	31.58	15.0		
813H48	(716H29 x 734) x 713A	10,380	7,880	24.0	37.73	32.61	14.0		
813H49A	(716H0 x 760) x F66-13	10,390	7,840	24.0	37.44	31.49	16.0		
713H4	569H3 x 613A	9,670	7,300	25.0	34.20	29.30	14.0		
813H47	(705H25 x 751) x 713A	9,850	7,400	25.0	34.53	29.36	15.0		
813H8	546H3 x 713A	10,130	7,210	29.0	37.35	29.24	22.0		
813TH40	(754H0 x 760) x 713T	10,000	7,090	29.0	38.74	30.06	22.0		
Y804H8	546H3 x Y704	10,460	7,380	29.0	38.65	30.74	20.0		
U813H4	569H3 x F66-13 (US H9A)	9,700	6,550	32.0	34.52	26.99	22.0		
U813H8	546H3 x F66-13 (US H9B)	10,090	6,800	33.0	36.35	28.47	22.0		
F66-13H11	(563H0 x 550) x 413	10,680	7,080	34.0	39.10	29.75	24.0		
Y803H4	569H3 x Y603	11,200	7,170	36.0	39.31	28.28	28.0		
664H4	569H3 x 664 (US H7)	9,710	5,800	41.0	33.79	24.19	28.0		
868H4	569H3 x F57-68	10,190	5,600	45.0	36.10	23.90	34.0		
Mean		10,100	7,250	28.0	36.36	29.44	19.0		
LSD (.05)		NS	932	8.1	3.67	3.06	7.3		
Coefficient of Variation		7.41	10.21	23.05	8.02	8.26	30.93		
F value		1.70	4.24**	6.26**	2.47**	4.99**	6.54**		

\*\*Exceeds the 1% point of significance (F=2.31)



Performance of hybrid sugarbeet varieties and reduction in yield under BYV-BMYV inoculated and noninoculated treatments at Davis, California, 1969 (continued).

Planted: May 22, 1969									
Inoculated: July 10, 1969									
Harvested: October 22, 1969									
(5 replications of each variety)									
(Two-row plots)									
(Split-block design)									
Variety	Description	Sucrose Percent		Sucrose		No. Rotted			
		Check	Inoc.	Loss Pct. pts.	Check	Inoc.			
813H42	(754H4 x 704) x 713A	14.3	12.7	1.61	7.8	4.4			
813H50	(705H24 x 705) x 713A	14.1	12.6	1.45	10.2	7.2			
813TH49	(716H0 x 760) x 713T	13.4	12.4	1.05	5.4	6.4			
613H4	569H3 x 513	14.0	13.0	0.93	4.4	3.6			
813H44	(705H24 x 714) x 713A	14.3	12.7	1.61	4.6	3.4			
813H46	(716H29 x 718) x 713A	13.7	12.4	1.30	6.6	5.4			
813H48	(716H29 x 734) x 713A	13.8	12.1	1.66	6.4	4.8			
813H49A	(716H0 x 760) x F66-13	13.9	12.5	1.43	8.0	4.0			
713H4	569H3 x 613A	14.2	12.5	1.70	7.2	4.0			
813H47	(705H25 x 751) x 713A	14.3	12.6	1.69	9.4	6.2			
813H8	546H3 x 713A	13.6	12.4	1.24	3.4	5.6			
813TH40	(754H0 x 760) x 713T	13.0	11.8	1.18	7.2	5.6			
Y804H8	546H3 x Y704	13.5	12.0	1.54	2.2	1.2			
U813H4	569H3 x F66-13 (US M1A)	14.1	12.2	1.91	5.6	3.0			
U813H8	546H3 x F66-13 (US H9B)	13.9	12.0	1.90	5.0	2.8			
F66-13H11	(563H0 x 550) x 413	13.6	11.9	1.78	3.8	2.8			
Y803H4	569H3 x Y603	14.3	12.7	1.54	3.2	3.2			
664H4	569H3 x 664 (US H7)	14.4	12.0	2.39	2.2	3.4			
868H4	569H3 x F57-68	14.1	11.7	2.41	3.2	3.0			
Mean		13.9	12.3	1.59	5.6	4.2			
LEP (.05)		0.48	0.76	--	4.01	2.97			
Coefficient of Variation		2.75	4.89	--	57.17	56.11			
F value		4.49**	1.85*	--	2.70**	2.10*			

\*Exceeds the 5% point of significance (F=1.81)

\*\*Exceeds the 1% point of significance (F=2.31)

The relative performance of yellows resistant varieties to BWV and BYV infection at Davis, California, 1969

(5 replications of each variety)  
(Two-row plots)  
(Split-block design)

Planted: May 22, 1969  
Inoculated: July 10, 1969  
Harvested: October 23, 1969

Variety	Description	Gross Sucrose/A		Gross Suc. Loss		Tons Roots/A		Yield Loss	
		Check	BWV	BYV	BYV	Check	BYV	BWV	BYV
				Percent	Percent			Percent	Percent
813	Inc. 8 YRS, 2 BS US 75	8,400	8,308	1.1	13.8	30.11	30.39	-0.9	8.3
Y801	YRS Y601	10,419	9,313	10.6	19.1	37.50	34.74	7.4	12.6
Y804	Inc. Y704	9,534	8,559	10.2	19.2	35.46	32.91	7.2	11.3
Y803	Inc. Y603	9,410	9,431	-0.2	26.5	32.17	32.52	-1.1	18.0
F68-413	Inc. 5 YRS IS 75	8,842	7,390	15.4	27.7	33.12	28.54	13.8	20.4
868	Inc. F57-68 (US 75)	9,200	7,205	21.7	41.4	33.26	28.95	13.0	31.9
7760H33A	6716H0 x 6760	10,535	9,299	11.7	21.0	37.40	35.25	5.7	14.1
7718H31	6705H25 x 6718	9,403	7,898	16.0	26.3	33.31	29.19	12.4	20.9
7734H32	6716H29 x 4734A	10,075	8,917	11.5	26.9	38.17	34.70	9.1	19.3
7705H30	6705H24 x 6705	8,739	7,444	14.8	29.6	29.43	26.48	10.0	20.8
Mean		9,456	8,376	11.3	25.2	33.99	31.37	7.7	17.8
LSD (.05)		828	852	--	--	2.50	3.10	--	--
Coefficient of Variation		6.82	7.92	--	--	5.72	7.69	--	--
F value		6.08**	8.35**	--	--	12.41**	8.09**	--	--

\*\*Exceeds the 5% point of significance (F=2.15)

\*\*Exceeds the 1% point of significance (F=2.94)

The relative performance of yellows resistant varieties  
to BWYV and BYV infection at Davis, California, 1969 (continued)

(5 replications of each variety)  
(Two-row plots)  
(Split-block design)

Planted: May 22, 1969  
Inoculated: July 10, 1969  
Harvested: October 23, 1969

Variety	Sucrose Percent			Sucrose Loss			No. of Roots/plot			% Rotted Roots		
	Check	BWYV	BYV	BWYV	BYV	Pct. pts.	Check	BWYV	BYV	Check	BWYV	BYV
	Pct. pts.			Pct. pts.			Pct. pts.			Pct. pts.		
813	13.94	13.69	13.10	0.25	0.84		61	59	56	12.7	14.3	7.6
Y801	13.89	13.39	12.87	0.50	1.02		63	63	64	1.4	0.9	0.4
Y804	13.45	13.01	12.27	0.44	1.18		65	65	61	5.3	7.0	1.4
Y803	14.61	14.51	13.11	0.10	1.50		50	50	48	0.0	0.0	0.0
F68-413	13.35	12.94	12.16	0.41	1.19		59	59	64	7.3	21.8	1.8
868	13.81	12.43	11.91	1.38	1.90		67	66	64	0.3	1.4	1.0
7760H33A	14.07	13.21	12.96	0.86	1.11		54	54	54	3.7	1.1	0.8
7718H31	14.10	13.48	13.10	0.62	1.00		65	66	67	0.6	6.5	1.2
7734H32	13.20	12.85	11.96	0.35	1.24		61	62	61	2.0	6.9	3.1
7705H30	14.86	14.06	13.19	0.80	1.67		66	63	65	0.6	2.8	0.7
Mean	13.93	13.36	12.66	0.57	1.27		61	61	60	3.4	6.3	1.8
LSD (.05)	0.67	0.75	0.57	--	--		10.46	NE	NE	4.92	5.67	2.22
CV	3.72	4.36	3.49	--	--		13.37	13.73	15.18	112.99	70.47	96.20
F value	5.15**	5.54**	7.00**	--	--		2.17*	1.93	2.01	5.61**	12.47**	8.26**

\*Exceeds the 5% point of significance ( $F=2.15$ )

\*\*Exceeds the 1% point of significance ( $F=2.94$ )



## INHERITANCE OF BEET MOSAIC VIRUS RESISTANCE IN SUGARBEET

R. T. Lewellen

Beet mosaic virus (BMV) occurs in sugarbeet in most areas where virus yellows is common. As with beet yellows virus and beet western yellows virus, BMV is readily transmitted by the green peach aphid, Myzus persicae. It is also easily transmitted by mechanical inoculation.

Resistance to BMV is not known to occur in commercial varieties of sugarbeet. However, an apparently high source of resistance was found in an annual, self-fertile line, 8500. The inheritance of resistance from this line is reported.

Crosses were made between homozygous 8500 and a susceptible, self-fertile, annual, homozygous line, C5600. A gametocide was used to obtain reciprocal crosses between 8500 and C5600. Because 8500 occurs in an equivalent cytoplasmic male sterile (cms) form,  $F_1$ 's were also obtained from 8500 cms x C5600. The male-fertile  $F_1$  crosses were selfed to obtain  $F_2$  seed. C5600 and 8500 were backcrossed to the cms  $F_1$ .

The inheritance of mosaic resistance was studied in the greenhouse using populations from the parents,  $F_1$ 's, reciprocal  $F_2$ 's, and backcrosses. Seed was planted in sand and four seedlings were transplanted to each six-inch pot. The plants were mechanically inoculated in the two-leaf stage.

In three tests it appeared that mosaic resistance from 8500 was controlled by a single gene. In early stages of infection the  $F_2$  ratio of resistant to susceptible plants fit a 3:1. Ratios of 1 resistant to 1 susceptible and all resistant were found in the  $F_1$  x C5600 and  $F_1$  x 8500 populations, respectively. At a later stage of infection, the  $F_2$  segregated into three classes: resistant, intermediate, and susceptible. The  $F_1$  x C5600 segregated into intermediate and susceptible classes and the  $F_1$  x 8500 into resistant and intermediate classes. Generally there was a significant fit to a 1:2:1, 1:1, and 1:1 ratio for these populations, respectively. The  $F_1$  was classified as resistant early and then intermediate as infection time increased.

With all populations it was difficult to make some single plant classifications into a particular reaction group. In some instances the heterozygote appeared to vary from nearly as resistant as 8500 to nearly as susceptible as C5600. To determine the relationships between my  $F_2$  reaction designations and the true genotypic conditions and to substantiate that there is primarily one reaction gene, a random  $F_2$  population was saved and selfed. These  $F_3$  lines are being scored for mosaic reaction.



The level of resistance to BMV found in 8500 is not immunity and the mosaic symptoms of the parents show ~~some~~ variation for disease reaction. To estimate the resistance level ~~as~~ measured by virus concentrations, composited leaf samples of the parents, F<sub>1</sub>, F<sub>2</sub>, and backcross populations and certain selected classifications from the segregating populations were tested ~~on~~ a local lesion host, Chenopodium amaranticolor. Paired comparisons using a half-leaf technique were made on each local lesion host plant. The number of lesions from 8500, the ~~cms~~ F<sub>1</sub>, and C5600 were low, intermediate, and high, respectively. The number of lesions from the F<sub>1</sub> ~~was~~ similar to the composited F<sub>2</sub>. The 8500 and C5600 backcross populations were lower and higher than the F<sub>1</sub>, respectively.

The male-fertile F<sub>1</sub>'s were crossed to a number of other lines containing genetic marker genes. F<sub>2</sub> and backcross seed has been obtained, and these populations will be grown to determine if mosaic resistance is linked to YRB, aa, mm, or s<sup>1</sup>s<sup>1</sup>.

This source of ~~BMV~~ resistance is also being backcrossed into several open-pollinated varieties and components of commercial hybrids. After several backcrosses and a sib cross to obtain homozygosity, the actual level of resistance to ~~BMV~~ will be determined using field tests.

## A PAPER-POT TRANSPLANTING TECHNIQUE TO DETERMINE DISEASE LOSS

R. T. Lewellen, I. O. Skoyen, and T. Takeda

Mr. Takeo Takeda, a Foreign Research Associate from the Japan Sugar Beet Improvement Foundation, Sapporo, Japan, visited the U.S. Agricultural Research Station from March to October in 1969. During his stay at Salinas, we cooperated in a sugarbeet transplanting experiment to evaluate this method as a means of determining disease reaction and loss.

A hybrid variety, US H8, was planted in the greenhouse at two dates, April 14 and April 28, in No. 1 (13.5 cm long x 19 mm diameter) paper pots. The plants were thinned to one per pot. On May 9 one-half of the plants from each planting date were inoculated with a combination of HIV and BWYV. The plants were in the 3 to 4-leaf and cotyledon stages for the first and second planting dates, respectively. The plants with paper pots intact were transplanted to the field May 13. The four treatments were planted in a latin square design with single-row plots 41.8 feet long and 28 inches wide. Fifty plants were transplanted to each plot. Our standard cultural practices for field tests were then used. Two sprayings of Meta-systox R were used to control natural infection, but by early July the test was uniformly infected with yellows.

The results of this test are shown in the accompanying table. There were no significant differences for percent sucrose. For beet yield the yellows inoculated treatments were significantly lower than the noninoculated treatments. The interactions were not significant. The yellows infection caused a 47.1 percent loss.

The yield loss in this experiment was greater but in line with the losses for this variety from previous field tests. The greater loss was probably partially attributable to the early stage of infection. The paper-pot transplanting method appears to be an adequate method for testing disease reaction and loss. However, it will probably have greater value for a disease, e.g. curly top, in which controlled inoculations in the field are more difficult than they are for yellows.

Performance of yellows and planting date treatments from a paper-pot transplanting experiment at Salinas, California, 1969.

Treatment	Beet Yield <sup>1/</sup>	Sucrose <sup>1/</sup>	Yellows Symptoms <sup>2/</sup>	Harvest Count
	Tons/A	Percent	June 12	Per Plot
Noninoculated, cotyledon	18.67 <sup>a</sup>	14.3 <sup>a</sup>	0.45	46
Noninoculated, 3-4 leaves	19.48 <sup>a</sup>	14.0 <sup>a</sup>	0.44	46
Inoculated, cotyledon	9.43 <sup>b</sup>	13.7 <sup>a</sup>	1.98	47
Inoculated, 3-4 leaves	10.77 <sup>b</sup>	13.7 <sup>a</sup>	1.99	47
Mean	14.59	13.9		

<sup>1/</sup> Treatment means followed by the same letter are not significantly different at the 1% level of probability.

<sup>2/</sup> Yellows symptoms were recorded for each plant on the basis of 0 = no symptoms, 1 = light symptoms, and 2 = definite symptoms.

#### VARIANCE TABLE

Source	d.f.	Mean Squares	
		Beet Yield	% Sucrose
Treatments	3	2,186.4**	0.38
Inoculation	1	6,460.1**	0.88
Planting date	1	92.6	0.13
Inoc. x Plt. date	1	5.6	0.11
Blocks	3	73.6	1.75
Error	9	74.6	0.33

Total 15

\*\*Significantly different at the 1% level of probability.

COMPARISON OF THE AMINO ACID RATIO OF A YELLOWS-RESISTANT  
SELECTION, MADE ON THE BASIS OF THE AMINO ACID RATIO,  
WITH RATIOS OF CERTAIN OTHER SUGARBEET VARIETIES

by

J. M. Fife

Investigations have shown that mass selection of sugarbeets on the basis of root weight and the amino acid ratio resulted in selections having significant resistance to beet yellows and especially so with respect to the percentage sucrose in plants infected with a virulent strain of the beet yellows virus. It has also been shown that the concentrations of aspartic acid, glutamic acid and glutamine are, to a large extent, genetically controlled in the leaves of beet yellows-infected plants and that the amino acid ratio (concentration of aspartic acid + glutamic acid to that of glutamine) is significantly greater in leaves of selections made on the above basis than in the parent variety.

The studies reported here were made to determine if a selection, RS-3, (made for yellows resistance on the basis of root weight and the amino acid ratio in infected leaves) has a different amino acid ratio than other sugarbeet varieties, and to determine if the amino acid pattern changes during a growing period under controlled nutritional conditions.

#### Methods and Results

Plants of varieties US 75, 413, C5600 and selection RS-3 were grown in the greenhouse under controlled nutritional conditions. Twenty five plants of each variety were inoculated in the late two-leaf stage with a virulent strain (Brawley) of beet yellows virus. The inoculated and an equal number of uninoculated plants of each variety were randomized on a table in the greenhouse. The first sampling was made soon after the chronic symptoms of the disease appeared (6 weeks after inoculation). Two newly-matured leaves, showing uniform chronic symptoms, and leaves of similar age were taken from the uninoculated plants. The plants were sampled again 6 weeks later. The concentrations of aspartic acid, glutamic acid and glutamine were determined, in duplicate, in the juice expressed from the leaf samples taken from each plant.



Table 1.

Amino acid ratios of three sugarbeet varieties and a selection made on the basis of the amino acid ratio in newly-matured leaves of beet yellows-infected plants.

Selection	Amino Acid Ratios <sup>1/</sup> Sampling & Condition			
	1st (H)	2nd (H)	1st (D)	2nd (D)
RS-3 (Selection)	.98	1.20	.63	.64
US 75 (Parent variety)	.74	.86	.48	.58
413	.76	.93	.48	.69
C5600	.62	.89	.44	.56

<sup>1/</sup> Concentration:  $\frac{\text{Aspartic acid} + \text{Glutamic acid}}{\text{Glutamine}}$

Table 2.

Comparison of amino acid ratios of three sugarbeet varieties with a selection, RS-3, made from a commercial variety on the basis of the amino acid ratio.

Ratio of Amino Acid Ratios	Ratios, Sampling & Condition			
	1st (H)	2nd (H)	1st (D)	2nd (D)
Selections				
US 75 to RS-3	.76	.72	.77	.91
413 to RS-3	.77	.77	.77	1.08
C5600 to RS-3	.63	.74	.70	.88

The amino acid ratio of selection RS-3 was significantly greater than the three varieties in both samplings of the healthy plants and also the first sampling of the inoculated plants (Table 1). The amino acid ratios increased significantly during the interval between samplings in both healthy and inoculated plants of the sugarbeet varieties. Despite these changes, the ratio of the amino acid ratios of the varieties to that of selection RS-3 remained practically unchanged for both samplings of the healthy plants and for the first sampling of the inoculated plants (Table 2).

The amino acid ratio of infected plants of selection RS-3 remained constant during the growing period (Table 1). It appears that the plants of the varieties were able to adjust to the presence of the beet yellows virus. This is shown by the highly significant increase in the amino acid ratios of all three varieties in the second sampling over that of the first. In fact, plants of variety 413, (which has resistance to beet yellows) recovered from the upset in the amino acid metabolism to such an extent that the ratio was equal to that of selection RS-3, which also has resistance to beet yellows.

#### Summary

Healthy and beet yellows-infected leaves of ■ yellows-resistant selection RS-3, made on the basis of root weight and the amino acid ratio, have amino acid ratios significantly greater than leaves, of similar age and condition, of three sugarbeet varieties in the early stages of growth. As the growing season progresses, these differences between the selection and the varieties become less.

Since there is a significant recovery from the upset in the amino acid metabolism of sugarbeet plants infected with beet yellows, it appears that selection for resistance to beet yellows, on the basis of the amino acid ratio in leaves of yellows-infected plant populations, should be made soon after the appearance of the chronic symptoms of the disease.

# BOLTING OF SUGARBEETS INCREASED BY SELECTING FOR RESISTANCE TO BEET YELLOWS ON THE BASIS OF THE AMINO ACID RATIO

by

J. M. Fife

It has been shown that rapid progress may be made by breeding for resistance to beet yellows, and possibly to beet western yellows, by mass selection on the basis of root weight and the amino acid ratio (ratio of sum of the concentrations of aspartic and glutamic acids to that of glutamine) in newly-matured leaves of sugarbeet plants infected with a virulent strain of beet yellows virus.

The results reported here show that the bolting tendency, of sugarbeet selections made on the basis of the amino acid ratio, was greatly increased over that of the parent variety.

## Methods and Results

The parent, variety US 75, originated from seed produced at Medford, Oregon. The seed of this variety was planted in September, 1949 and 1950 at Salinas, California to determine its original bolting resistance. The percentage bolters was 39% and 50% respectively. Non-bolting selections reduced the bolting tendency to 10% in two tests (December plantings) made by McFarlane in 1967. This was the bolting tendency of the parent (variety US 75).

The selections were made from populations of beet yellows-infected plants, grown in the greenhouse under controlled nutritional conditions, on the basis of root weight and the magnitude of the amino acid ratio. The selected roots were potted and 4 to 6 leaves allowed to develop in the greenhouse. The plants were then given 130 days thermal induction at 42°F under continuous light from fluorescent tubes and Mazda lamps. All plants bolted and produced seed.

A bolting test for the first selections was made in 1961. Seed of the selections, the parent and a commercial variety (Spreckels) was planted in a plot in a commercial field at Salinas, California. The second successive selections and the parent were in two replicated tests, conducted by McFarlane at Salinas (Table 1).

All first selections bolted even though the amount of thermal induction received was very limited. The parent and the commercial variety did not bolt. The percentage bolting of the second successive selections was three-fold greater than the parent variety in both tests.

Had the plantings been made in September (instead of December), and the temperature conditions similar to that in 1950 and 1951, it is possible that the bolting of the second successive selections would have been restored to that of the parent (39% and 50% respectively) before a selection for non-bolting was made.

### Summary

The bolting tendency of sugarbeet plants may be altered to a marked degree by selection on the basis of the concentrations of aspartic acid, glutamic acid and glutamine in the leaves.

Table 1.

Change in bolting tendency of sugarbeet selections made on the basis of the amino acid ratio and root weight for resistance to beet yellows.

Selection	Planting Date	Selection Basis		Bolting %
		Amino Acid Ratio	Root Weight	
Commercial Variety	Jan. 11, 1961			0
US 75 (Parent)				0
91DS-9 1st Sel.		> $\bar{X}$	> $\bar{X} + 2s$	6
91DS-22 1st Sel.		> $\bar{X}$	> $\bar{X} + 2s$	6
91DS-24 1st Sel.		> $\bar{X}$	> $\bar{X} + 2s$	4
101RS-1 1st Sel.		> $\bar{X} + 2s$	> $\bar{X} + 2s$	14
101RS-3 1st Sel.		> $\bar{X} + 2s$	> $\bar{X} + 2s$	14
302R-9 1st Sel.		> $\bar{X} + 2s$	> $\bar{X}$	20
302R-6 1st Sel.		> $\bar{X} + 2s$	> $\bar{X}$	8
US 75 (Parent)	Dec. 20, 1967 <sup>1/</sup>			10.7
RSC-C 2nd Suc.		> $\bar{X} + 2s$	> $\bar{X} + 2s$	35.4
RS-3 2nd Suc.		> $\bar{X} + 2s$	> $\bar{X} + 2s$	44.8
US 75 (Parent)	Dec. 21, 1967 <sup>1/</sup>			9.5
RSC-C 2nd Suc.		> $\bar{X} + 2s$	> $\bar{X} + 2s$	27.8
RS-3 2nd Suc.		> $\bar{X} + 2s$	> $\bar{X} + 2s$	36.9

<sup>1/</sup> Bolting data courtesy, J. S. McFarlane and I. O. Skoyen.



## VIRUS INVESTIGATIONS

J. E. Duffus

Beet western yellows virus is similar in host reaction and aphid transmission to a number of other aphid-transmitted viruses, including potato leafroll virus, barley yellow dwarf virus, beet mild yellowing virus, turnip latent virus, *Physalis* mild chlorosis virus, turnip yellows virus, etc. Undoubtedly some of the reported yellows type viruses are related. The application of the membrane feeding technique (Duffus and Gold, 1965) to in vitro property tests and infectivity neutralization tests (Gold and Duffus, 1967) may clarify the relationships.

Such information could be very important in programs of breeding for resistance to virus yellows of sugarbeet. For example, if beet western yellows virus (BWYV) and one or more of the other viruses such as beet mild yellowing virus (BMV) are shown to be unrelated or only distantly related to each other, it is unlikely that plants which are resistant to one virus will necessarily be resistant to the other. Under these circumstances both BMV and BWYV would be a threat to sugarbeet in America and Europe and it would be necessary to test simultaneously for resistance to BWYV, BMV and BYV in both continents. If, on the other hand, BWYV and BMV are closely related, resistance to one virus would probably be associated with resistance to the other and the present programs of breeding for resistance to virus yellows in Europe and America are probably adequate.

The application of a membrane-feeding technique to the study of the in vitro properties of beet western yellows virus (BWYV) indicates differences between this virus and others of this group; and these are of value in determining procedures for the purification of the virus. (See Abstract Duffus, 1969).

During a survey of beet yellowing viruses in eastern England in August, 1968, leaves were collected from chlorotic lettuce (*Lactuca sativa* L.) plants in two fields near Potton, Bedfordshire. Most plants in these lettuce crops were stunted and their older leaves showed an intense interveinal yellowing. These symptoms closely resembled those caused by beet western yellows virus (BWYV) in lettuce in California (Duffus, 1960). Accordingly, a series of transmission experiments was carried out under glass at the Plant Breeding Institute in cooperation with Dr. G. E. Russell to determine if BWYV or a similar virus was responsible for the yellowing of lettuce at Potton. These studies confirmed the presence of a persistent, aphid-transmitted yellowing virus in lettuce crops in England. The severe chlorosis and stunting of infected plants, and the high incidence of infection in the sampled crops, suggest that this virus disease may be of considerable economic importance in lettuce crops.

The identity of the causal virus is uncertain but its transmission characteristics, host range and symptomatology indicate that it is related to the group of yellowing viruses which comprises BWYV (Duffus, 1960) and beet mild yellowing virus (BMV) (Russell, 1958). Preliminary serological investigations indicate a relationship to BWYV, however, more complete data will have to be obtained to verify this relationship. No isolate of yellowing virus from lettuce in England has so far infected sugarbeet in these experiments and no isolate of BMV tested so far has infected lettuce; the virus isolates from lettuce are, therefore, not typical BMV isolates and are probably not a hazard to beet crops in the vicinity of infected lettuce crops. In California, isolates of BWYV are implicated in "June Yellows" of lettuce and it is probable that BWYV is responsible for the virus-induced yellowing observed in lettuce in Bedfordshire. This would be the first record of BWYV outside the United States of America. (See Abstract Russell and Duffus, 1970).

Sowthistle yellow vein virus (SYVV), which induces a disease of sowthistle (Sonchus oleraceus L.) characterized by vein-clearing and vein-banding symptoms on the leaves, was first reported from California and Arizona in 1963 (Duffus, 1963) there appear to be no published reports of its occurrence outside the U.S.A. This virus has an unusually long latent period in its aphid vector, Hyperomyzus (Amphorophora) lactucae L., and its particles are bacilliform.

In studies on the possible occurrence of beet yellow stunt virus in Europe in cooperation with G. E. Russell, vein-clearing and vein-banding symptoms were observed on leaves of many S. oleraceus plants growing on waste ground near Cambridge in August, 1968. Adult H. lactucae, which had been reared on these plants, were transferred to S. oleraceus seedlings grown in an insect-proofed glasshouse and were allowed to feed on them for at least 24 hr. Vein-clearing symptoms developed on inoculated plants after approximately three weeks but not on uninoculated plants. Later transmission experiments, using H. lactucae cultured on virus-free sowthistle plants, showed that the pathogen had a minimum latent period in the vector of eight days.

Crude extracts from leaves of S. oleraceus were examined under the electron microscope using an epidermal-strip technique involving negative staining with 2 per cent phosphotungstate. Bacilliform particles, whose morphology agreed closely with that described for SYVV in the U.S.A., were observed in preparations from plants showing vein-clearing symptoms.

Similarities in symptomatology, transmission characteristics and particle morphology strongly suggest that the vein-clearing symptoms observed on S. oleraceus at Cambridge were caused by SYVV. Vein-clearing symptoms in Sonchus species in Britain have been reported previously but no evidence of virus infection was obtained. These

reports indicate that SYVV may be widely distributed in Britain and that the virus has not been introduced into Europe recently. (See Abstract Duffus and Russell, 1969).

Viruses of the Cruciferae are frequently encountered in studies dealing with the green peach aphid, Myzus persicae. One of the members of this group found frequently in studies at Salinas is turnip mosaic virus.

Turnip mosaic virus (TuMV) is geographically widespread. It is known to occur throughout the United States, Europe, South Africa, and in Asia. The virus induces serious diseases in a number of commercial crops and it has been frequently isolated from edible and ornamental species. The list of synonyms, strains, or suspected strains of this virus number over 40, indicating the impact that this virus has had on agriculture.

In general, the separation of the crucifer viruses and their strains is difficult by symptoms and host range studies. The use of specific antisera and electron microscopy provide the best method of distinction. Many agricultural field stations and most diagnostic laboratories, extension offices, etc., do not have the facilities for serological or electron microscopy studies. For these reasons a specific host reaction, found in recent studies to be capable of distinguishing all isolates of TuMV thus far tested, may be useful. (See Abstract Duffus and Zink, 1969).

In 1966, a mosaic disease of lettuce (Lactuca sativa L.) was observed in the Salinas Valley of California. The disease appeared to be restricted to the crisp-headed downy mildew resistant cultivar Calmar for it was not found in commercial plantings of Great Lakes and Cos. (See Abstract Zink and Duffus, 1969).

Studies indicated the causal virus was TuMV and susceptibility of lettuce cultivars was restricted to the crisphead types that are mildew resistant. Seventy two other cultivars tested, including Great Lakes and Cos, were immune (extreme resistance) to TuMV. Resistance to TuMV and mildew are each controlled by a single dominant gene. The TuMV-susceptible gene Tu is linked with the mildew-resistant gene, Dm. In the repulsion phase, the cross-over value was 12.5%. (See Abstract Zink and Duffus, 1970).



ULTRASTRUCTURE OF POLLEN DEVELOPMENT IN BETA  
by Lynn L. Hoefert

Characterization of stages in tapetal cell development and degeneration was the subject of a report at the International Botanical Congress in Seattle, August, 1969. Some preliminary observations on cytoplasmic male sterile anthers, and earlier observations of Artschwager (1947), indicate that precocious tapetal cell degeneration accompanies cytoplasmic male sterility. Ultrastructural studies are under way to determine the sequence of tapetal cell degeneration. A manuscript on normal tapetal cell degeneration is in preparation.

Virus Diseases of Sugarbeets

Work with virus diseases during the past year has been directed toward collecting variously diseased plants and establishing methods of killing and fixation that adequately preserve fine structure. Attempts have been made to collect several different hosts infected with the different viruses. Further efforts will be directed toward recognition of the viruses in host cells and definition of the cytopathic effects of each virus. Attempts will be made to follow infections from a developmental or ontogenetic approach in order to characterize initial and subsequent effects of the viruses, including cell to cell and long distance virus movement.

Artschwager, E. 1947. J. Agr. Res. 75:191-197.



## Progress Report

### Breeding Sugarbeet for Resistance to the Sugarbeet Nematode Heterodera schachtii Schm.

Devon L. Doney and E. D. Whitney

#### A. Breeding

##### Cycle 1

In 1968, 57 roots were selected from a space planted, uniform inoculated field trial. These selections received thermal induction in the winter of 1968-69 and were planted in the field for seed increase in the spring. In order to make the necessary crosses to expedite the planned recurrent selection program, asexual reproduction was necessary. The method of asexual reproduction used was by rooting of cuttings.

About 20 of the original selections were discarded. Approximately 1,000 cuttings were rooted from the remaining selections. There was a marked difference in the rooting ability of the selections. One factor affecting rooting ability was the incidence of virus yellows in the mother beets. The rooted cuttings were reverted to the vegetative stage by decreasing the day length and then planted in the field to allow the cuttings to grow a small storage organ before harvest. These rootings were harvested in the fall and placed in thermal induction chambers. The necessary crossing will take place in the summer of 1970.

##### Cycle 2

#### a. Crossing

Eight different sources of germ plasm were selected and placed into one of two groups (table I). All possible combination of crosses were made in isolation chambers in the winter of 1968-69. This made possible the testing for combining ability of parents in this diallel cross. However, the present nematode testing plots are not large enough for such large scale testing. Therefore, the material was arranged in 5 different trials such that maximum information could be obtained on the combining ability of sources in group A with sources in group B and vice versa.

#### b. Field Tests

(i) Layton, Utah (cooperative project with U & I Sugar Company)

This test trial consisted of 16 entries (table II) replicated 12 times in 40 foot plots. (A field in Layton, Utah was selected having a uniform high nematode population for this trial). It was planted April 30, 1969. Weather conditions necessitated irrigation to germinate the seed and resulted in rather poor stands. The test trial was in a field of commercial sugarbeets, therefore, the agricultural practices were the same as for commercial sugarbeets.

There was a high incidence of curly top in this trial, therefore, curly top ratings were made in mid season (table II). Entries RRS 1 and RRS 8 and Hybrid 8 had some resistance with RRS 8 and Hybrid 8 the most resistant. The data are in accordance with the known curly top resistance of these varieties. Wilting ratings were also taken during mid season (table II). Entry RRS 7 has shown some wilting resistance in other areas, however, it wilted just as severely as the other entries in this trial.

Plots were harvested on October 6, 1969 and data taken on clean weight and percent sucrose. Because of poor stands all plots could not be harvested making it impossible to compute a statistical analysis. Mean yield and percent sucrose data are also shown on table II. The effect of curly top was so great that it masked the nematode effects, and yield data indicate curly top resistance rather than nematode resistance.

(ii) Test trials 906S1 and 906S2

Test trials 906S1 and 906S2 were at the Salinas station. These two trials were similar except for the nematode population density in the testing area. Nematode population density was high in the 906S1 area and low in the 906S2 area. The design was a randomized block with six replications. Plots were one 20 foot row per plot. The trials were planted May 13 and harvested October 14.

Wilting ratings were taken August 22 after an extended interval between irrigations. Entries RRS 7 and RW 167A have been shown in earlier tests to exhibit some wilt resistance. These two entries showed less wilting (table III) than the other entries. RRS 7 also appeared to transfer some wilt resistance to its offspring (table III). Mean clean weights, percent sucrose and total sucrose for each entry in the two trials are shown in table III.

(iii) Test trial 906P1

This trial consisted of 10 entries (table IV) replicated 6 times in 20 foot plot rows. The design was a split plot with fumigated and non-fumigated as whole plots. Fumigation was with DD about 4 weeks prior to planting. (The trial was planted May 13 and harvested October 15). Wilting ratings were taken on August 22. Entries RRS 7, RW 010, RW 168, RW 169 and RW 167A have been shown to have some wilting

resistance in earlier tests. Three of these entries (RRS 7, RW 168 and RW 167A) did exhibit some wilt resistance (table IV). The clean weights, percent sucrose and calculated total sucrose for nematode and fumigated plots are shown in table IV. The fumigated plots out-yielded the nematode plots by about 60 percent. There was no difference in percent sucrose between the nematode and fumigated plots. The crosses generally yielded better than their parents, indicating some heterosis.

(iv) Test trial 906P2

The testing area for this trial has been infested with nematodes for about 10 years with sugarbeets grown in it every year. Therefore, this testing area was fairly uniform with a medium heavy nematode population. It was planted May 13 and harvested October 15. The design was a randomized block. Data taken were clean weight and percent sucrose (table V). Total sucrose was also calculated (table V).

The test trials this year were set up to progeny test the RRS numbers. The general combining ability for each of the RRS numbers in their respective trials for clean weight, percent sucrose, and total sucrose are presented in tables VI, VII, and VIII.

Four lines (RW 010, RW 168, RW 169 and RW 167A) obtained from H. Rietberg of The Netherlands and a variety (Zwaan Poly) of the Zwanesse Seed Company in Holland were included in the trials this year. Of the RW lines, RW 010 showed the most promise (table IV). Zwaan Poly yielded very well in both trials it was included in (tables III and V). It was superior in the nematode trial 906P2 (table V).

The desirable comparisons are among parents within each group. Within group A, Parent RRS 2 had the best combining ability with RRS 4 next. Parents RRS 7 and RRS 8 were the better combining ability parents in group B. These data suggest that cross 2 x 7 should be a superior cross. Evidence to support this hypothesis can be seen in table III.

The specific combining ability or heterosis was also measured. Heterosis can be measured either by using the midparent or the high parent as a reference point. Most of the crosses yielded greater than their midparent in clean weight and total sucrose, but were close to their midparent in percent sucrose. This indicates an additive gene effect for percent sucrose and a non-additive gene effect for root yield.

A summary of heterosis greater than the high parent for each of the RRS numbers is presented in table IX. Those having a negative heterosis were RRS 8 and RRS 2, however, RRS 2 exhibited a positive heterosis for percent sucrose and total sucrose. The progeny of RRS 7 exhibited the most heterosis with the mean heterosis for total sucrose being significantly greater than the mean of the high parents. These data will serve as the basis for the selection of parents for the next cycle.



### c. Field Selection

In 1968 a method of selecting individual roots from space planted progeny in the field was started. A trial for individual root selection similar to the 1968 trial was conducted in 1969. In the 1969 trial approximately 2 liters of nematode soil containing 55 viable cysts per 100 grams of soil was added to holes prior to planting. Plantings were made on May 23. Early in the season a great deal of nematode damage was observed and many seedlings died shortly after emergence. All surviving roots were harvested October 15, weighed and individually analyzed for percent sucrose. Means and variances were computed and probabilities for genetic deviates placed on each root for percent sucrose and root yield. Individual data were adjusted for variety and replicate variation prior to the estimation of probabilities. From these probabilities genetically superior roots were selected for future breeding purposes.

The means, variances and probabilities of genetic variance are presented in table X. F58-554H1, a uniform hybrid, and 52-305, an inbred, were included for estimation of environmental variance. There was less measurable genetic variation in the 1969 trial than in the 1968 trial. However, there was sufficient to select a number of genetically superior selections.

### B. Genetic studies of interspecific progenies (cooperative study with Dr. Helen Savitsky)

A number of  $B_2$  progenies and one  $B_4$  progeny were obtained from Dr. Helen Savitsky's *vulgaris-procumbens* crosses to test for mode of inheritance. All plants had been previously tested and rated as being susceptible or resistant to the sugarbeet nematode.

The plants were repotted and inoculated with 2,000, 3,000, 4,000, 5,000, and 6,000 nematode larvae on the 3rd, 4th, 5th, 6th, and 7th week, respectively after repotting. Four months later the plants were harvested, weighed, and a soil sample taken from each pot to estimate the nematode population.

There were some differences between progeny mean root weights and nematode populations but not large differences (table XI). Most lines exhibited a significant genotypic variance for root weight and nematode population (table XI). This would indicate a quantitative type of resistance. However, there was a group of 20 plants that had very small nematode populations (less than 10 cysts per 100 grams of soil). Three-fourths of this group had large abnormal growths on the roots, which indicate genetic imbalance. All those with very small nematode populations were selected for crossing and further testing.



Another series of *B<sub>1</sub> vulgaris-procumbens* lines were intercrossed and their progenies tested for infection rate. This testing was accomplished by inoculating three-week old plants growing in clear plastic vials with 3,000 nematode larvae and counting the white females at the soil-vial interface four weeks later. A uniform hybrid, F60-554H1 was included as a check. Two tests were conducted; one in July and one in November (table XII). Good agreement was obtained in both tests (table XII). The check variety was higher in both tests than the selections (table XII); but there was no measurable genetic variation within lines in either test. Additional tests on this same material are being planned.

#### C. Selection in temperature controlled chambers

During the past several years many attempts have been made to control the environmental variation associated with nematode infestation. Control of this variation is necessary to insure progress through selection. One method that has shown promise in controlling much of this environmental variation has been some temperature controlled greenhouse benches, in which 6-inch pots are placed in insulated temperature controlled boxes while the sugarbeet foliage is exposed to the normal greenhouse temperatures. This closely simulates field conditions but with more control on temperature and moisture.

An experiment involving a uniform hybrid, a nematode tolerant line and a highly heterozygous line under these controlled conditions gave very little genetic variation. There were large nematode effects, but little difference between varieties. Due to the lack of genetic variation, genetic deviates were not observed.

In connection with this experiment a test was conducted on rate of root growth and nematode infection on the above mentioned lines. Nematode infection increased with time in terms of total nematode infection as well as nematode infection per gram of root (table XIII). There was little difference between the three varieties in root weight, total nematode infection, or nematode infection per gram of root (table XIII).

Table I. Source material for Cycle 2 of breeding program.

Group	Code	Source Material
A	RRS1	Charles Price Nematode Selections (USDA)
A	RRS2	G. J. Curtis Nematode Selections (Cambridge, England)
A	RRS3	Broadbase Synthetics (Great Western Sugar Co.)
A	RRS4	Introductions from Poland
B	RRS5	Nematode Root Rot Selections (American Crystal Sugar Co.)
B	RRS6	C. Smith Nematode Selections (USDA)
B	RRS7	Nematode Selections (H. Rietberg, The Netherlands)
B	RRS8	Source material of US H9 (USDA)

Table II. Mean root yield, percent sucrose, wilt rating and incidence of curly top for Layton nematode trial.

Entry	Yield Tons/Acre	% Sucrose	Wilt Rating	Incidence of Curly Top
RRS1	21.5	11.7	3.75	1
RRS2	13.6	13.0	6.90	5
RRS3	14.1	11.6	6.00	3
RRS7	14.7	13.1	5.45	1
RRS8	20.7	11.7	4.33	0
1 x 2	23.1	11.8	4.36	4
1 x 3	22.0	11.7	5.00	2
1 x 7	27.6	11.8	4.00	7
1 x 8	25.1	11.8	3.91	3
2 x 3	18.7	12.3	5.91	3
2 x 7	13.5	13.0	6.36	4
2 x 8	18.1	12.2	5.55	4
3 x 7	17.0	12.5	6.70	10
3 x 8	18.0	11.8	5.17	1
7 x 8	23.3	12.3	4.45	2
Hybrid 8	25.6	12.6	3.75	0

Table III. Mean root yield, percent sucrose, total sucrose and wilt rating for each of the entries in test trials 906S1 and 906S2.

Entry	Test 906S1				Test 906S2			
	Weight tons/acre	% Sucrose	Total suc. lbs./acre	Wilt rating	Weight tons/acre	% Sucrose	Total suc. lbs./acre	Wilt rating
1 x 5	19.2	17.1	6,589	9	24.2	17.3	8,319	3
1 x 6	15.6	17.5	5,471	9	19.6	17.3	6,740	3
1 x 7	17.7	17.3	6,100	6	23.6	17.5	8,225	5
1 x 8	18.2	16.8	6,129	7	23.9	17.5	8,394	5
2 x 5	17.3	17.7	6,129	10	23.2	17.4	8,319	5
2 x 6	--	--	--	--	25.1	18.1	9,090	5
2 x 7	15.5	18.3	6,072	8	26.3	17.9	9,391	5
2 x 8	--	--	--	--	26.3	17.4	9,109	4
3 x 5	16.1	17.5	5,659	5	22.9	16.8	7,670	7
3 x 6	14.9	17.1	5,123	6	21.0	16.8	7,041	7
3 x 7	18.3	17.5	6,430	4	24.6	17.0	8,394	3
3 x 8	19.3	17.4	6,702	5	23.5	17.0	7,981	3
4 x 5	18.1	17.9	6,514	5	20.3	17.3	7,022	3
4 x 6	16.7	17.6	6,007	9	20.7	17.3	7,153	8
4 x 7	17.3	18.2	6,213	5	23.8	17.9	8,310	3
RRS1	15.6	17.3	5,349	7	23.1	17.0	7,811	3
RRS2	18.5	18.2	6,683	8	24.8	17.6	8,478	3
RRS3	--	--	--	--	22.1	16.4	7,229	3
RRS4	14.9	18.4	5,471	12	19.1	17.8	6,815	4
RRS5	14.3	17.9	4,700	8	21.7	17.3	7,520	4
RRS7	15.9	17.7	5,658	5	22.6	17.6	7,971	2
RRS8	18.9	17.5	6,702	12	27.1	17.2	9,325	7
Zwaan Poly	--	--	--	--	26.3	17.1	8,949	5
RW 167A	17.6	17.9	6,279	4	26.5	17.0	9,024	3
LSD .05	4.3	0.6	1,372	--	2.6	0.8	921	--

Table IV. Mean root yield, percent sucrose and total sucrose for nematode and fumigated plants and mean wilt rating for each of the entries in test trial 906Pl.

Entries	Weight tons/acre		% Sucrose		Total Suc. lbs./acre		Wilt rating <sup>a</sup>
	Nema.	Fum.	Nema.	Fum.	Nema.	Fum.	Nema.
RRS3	10.4	18.5	14.4	13.8	2,980	5,114	3.0
RRS4	7.9	18.1	15.9	15.8	2,519	5,706	4.2
RRS7	12.7	22.0	15.6	15.1	3,986	6,627	2.3
3 x 4	10.8	22.9	14.9	14.6	3,215	6,702	3.2
3 x 7	13.1	23.3	15.4	14.7	4,042	6,890	3.0
4 x 7	10.9	21.2	16.3	16.5	3,591	7,050	2.3
RW 010	14.4	25.0	15.9	15.7	4,606	7,896	3.0
RW 168	13.0	22.2	15.9	15.9	4,155	7,144	2.3
RW 169	--	22.4	16.1	15.9	--	7,153	3.1
RW 167A	12.4	21.4	15.7	16.0	3,901	6,881	1.3
LSD .05	2.25	2.25	0.8	0.8	1,100	1,100	0.9

a = 1 = No. wilting & 5 = Severe wilting.

Table V. Mean root yield, percent sucrose and total sucrose for each of the entries in test trial 906P2.

Entries	Weight tons/acre	% Sucrose	Total Sucrose lbs./acre
RRS1	12.3	15.4	3,835
RRS2	13.1	15.9	4,202
RRS5	13.1	16.0	4,202
1 x 2	14.9	15.6	4,691
1 x 5	12.1	15.8	3,910
1 x 6	11.1	15.7	3,487
2 x 5	13.7	16.0	4,390
2 x 6	12.4	16.0	4,014
Zwaan Poly	17.5	15.7	5,508
LSD .05	2.6	0.4	827



Table VI. Combining ability for root yield (tons/acre) for each parent in each trial.

Group	Parent	Trial				
		Layton	906S1	906S2	906P1	906P2
A	RRS1	24.3	17.7	22.4	--	12.7
A	RRS2	18.4	18.4	24.9	--	13.8
A	RRS3	19.0	17.1	22.8	17.6	--
A	RRS4	--	17.4	21.6	16.5	--
B	RRS5	--	17.7	23.4	--	12.9
B	RRS6	--	16.3	21.9	--	11.7
B	RRS7	20.4	17.5	24.9	17.2	--
B	RRS8	21.1	19.1	24.6	--	--
LSD .05	--	--	2.1	1.5	2.2	1.5

Table VII. Combining ability for percent sucrose for each parent in each trial.

Group	Parent	Trial				
		Layton	906S1	906S2	906P1	906P2
A	RRS1	11.8	17.2	17.3	--	15.7
A	RRS2	12.3	17.9	17.9	--	15.9
A	RRS3	12.1	17.4	17.1	14.9	--
A	RRS4	--	17.9	17.7	15.6	--
B	RRS5	--	17.6	17.3	--	15.9
B	RRS6	--	17.5	17.5	--	15.9
B	RRS7	12.4	17.8	17.6	15.8	--
B	RRS8	12.0	17.3	17.3	--	--
LSD .05	--	--	0.3	0.3	0.4	0.3

Table VIII. Combining ability for total sucrose (lbs./acre) for each parent in each trial.

Group	Parent	Trial				
		Layton	906S1	906S2	906P1	906P2
A	RRS1	5,751	6,072	7,764	--	4,033
A	RRS2	4,526	6,589	8,930	--	4,371
A	RRS3	4,584	5,978	7,699	5,217	--
A	RRS4	--	6,241	7,492	5,142	--
B	RRS5	--	6,223	8,103	--	4,155
B	RRS6	--	5,790	7,623	--	3,750
B	RRS7	5,051	6,204	8,667	5,386	--
B	RRS8	5,051	6,570	8,498	--	--
LSD .05	--	--	675	536	592	470

Table IX. Mean heterosis for clean weight, % sucrose and total sucrose for seven RRS parents.

	Clean Weight	% Sucrose	Total Sucrose
RRS1 x group B	- .01	- .16	106
RRS2 x group B	- .50	+ .01	30
RRS3 x group B	.48	- .24	140
RRS4 x group B	.69	- .16	35
RRS5 x group A	.54	- .32	- 48
RRS7 x group A	.72	- .06	380*
RRS8 x group A	- 1.58	- .25	- 630

\* = Mean of crosses significantly greater than mean of high parents at p = .05

LSD .05 (between any two RRS nos.)	1.18	.35	408
------------------------------------	------	-----	-----

Table X. Means, genetic variances and probabilities for root yield and percent sucrose for each of the populations in the field selection trial.

Entries	Root Yield			Percent Sucrose		
	Mean (g.)	Genetic Variance	Probability <sup>b</sup>	Mean	Genetic Variance	Probability <sup>b</sup>
1 x 2	1,031	134,815	.05	12.9	0.88	.40
1 x 3	990	16,491	.50	12.0	1.85	.05
1 x 4	1,024	46,994	.30	12.9	0.75	.40
2 x 3	1,126	163,227	.01	12.6	0.31	.50
2 x 4	999	104,752	.10	13.8	0.06	.50
3 x 4	1,155	157,349	.01	12.0	2.03	.05
5 x 7	1,072	79,022	.20	13.4	0.00	---
5 x 8	1,012	72,171	.20	13.1	1.54	.10
6 x 7	932	71,748	.20	12.5	0.62	.40
6 x 8	1,045	93,821	.10	12.5	0.14	.50
7 x 8	823	-0-	---	12.7	0.00	---
52-305	373	56,030 <sup>a</sup>	---	13.9	3.14 <sup>a</sup>	---
F58-554H1	935	238,356 <sup>a</sup>	---	12.6	3.60 <sup>a</sup>	---
LSD .05	142	---	---	0.5	---	---

<sup>a</sup> = Environmental variation.

<sup>b</sup> = Probability of a genetic variance being as large or larger by chance alone.

Table XI. Mean root weight, nematode population and genetic variances for root weight and nematode populations for each vulgaris-procumbens progeny.

Progeny	Generation	Root wt.		Nema. Count No./100 g. soil		No. having < 10 cysts/100 g. Soil
		$\bar{x}$	Genetic Var.	$\bar{x}$	Genetic Variance	
C6600	Inbred	28.1	85.8 <sup>(a)</sup>	379	62,108 <sup>(a)</sup>	0
3742	B <sub>4</sub>	40.0	230.1**	470	63,407*	5
3937	B <sub>2</sub>	38.1	133.1**	611	82,363**	1
3939	B <sub>2</sub>	35.4	285.8**	367	-0-	0
4263	B <sub>2</sub>	35.2	118.3**	397	41,399	4
4264	B <sub>2</sub>	32.3	17.5	561	65,120*	1
4613	B <sub>2</sub>	29.6	55.7*	505	47,211	1
4651	B <sub>2</sub>	40.2	138.7**	533	68,140*	2
4678	B <sub>2</sub>	33.2	164.7**	547	60,021*	2
4856	B <sub>2</sub>	37.0	156.2**	337	21,057	2
4790	B <sub>2</sub>	29.9	75.3*	433	8,261	2
LSD .05	--	7.6	--	162	--	--

(a) = Environmental variance.

Table XII. Mean nematode cyst count two separate tests for each progeny.

Progeny	Mean Nema. Count	
	July Test	Nov. Test
1-804-1	103	97
1-804-2	126	103
1-804-3	119	105
1-804-4	122	77
1-804-6	134	114
1-804-7	123	---
1-804-8	93	101
1-804-9	96	---
1-804-11	100	99
1-804-12	89	87
1-804-13	106	92
F60-554-H1	162	120
590-1	---	84
LSD .05	20	25

r (July x Nov.) = .63\*



Table XIII. Mean root weight and nematode population over a three month growing period for the three entries.

Date after Inoculation	Entry	Mean Rt. Wt. (grams)	Total nemas. per plant	Mean nemas. per g. of Rt.
1 week	F58-554H1	.23 <sup>a</sup>	675	151 <sup>a</sup>
"	590-9	.28 <sup>a</sup>	840	235 <sup>a</sup>
"	D2	.34 <sup>a</sup>	800	272 <sup>a</sup>
3 weeks	F58-554H1	2.90 <sup>a</sup>	937	2,720 <sup>a</sup>
"	590-9	2.13 <sup>ab</sup>	1,091	2,325 <sup>b</sup>
"	D2	1.95 <sup>b</sup>	1,397	2,725 <sup>a</sup>
5 weeks	F58-554H1	9.5 <sup>a</sup>	126	1,196 <sup>a</sup>
"	590-9	6.3 <sup>ab</sup>	165	1,043 <sup>ab</sup>
"	D2	4.9 <sup>b</sup>	202	991 <sup>b</sup>
9 weeks	F58-554H1	36.0 <sup>a</sup>	82	2,940 <sup>a</sup>
"	590-9	35.2 <sup>a</sup>	78	2,760 <sup>a</sup>
"	D2	28.4 <sup>a</sup>	94	2,680 <sup>a</sup>
13 weeks	F58-554H1	55.0 <sup>a</sup>	422	23,240 <sup>a</sup>
"	590-9	69.2 <sup>a</sup>	424	29,340 <sup>a</sup>
"	D2	41.2 <sup>a</sup>	611	25,180 <sup>a</sup>

Note = Any series of means followed by the same letter are not different at  $p = .05$ .

THE EFFECTS OF HETERODERA SCHACHTII, APHANOMYCES COCHLIOIDES  
AND A COMPLEX OF THE TWO ON SUGARBEET

E. D. Whitney and D. L. Doney

A test in 1966 suggested that a synergistic effect between Aphanomyces cochlioides Drechs. and Heterodera schachtii Schm. on yield of sugarbeet may exist as was purposed by Price and Schneider (1) for H. schachtii and Rhizoctonia saloni Kühn. These data and data from similar tests in 1968 and 1969 to evaluate this possibility are presented.

Materials and methods:

Tests for 1966, 1968 and 1969 will be referred to as tests 1, 2, and 3, respectively. The tests were conducted under field conditions by growing sugarbeets (F<sub>1</sub> hybrid F58-554H1) in 2.5 gal. (approximately 14,000 g.) of soil in 3 gal. crocks placed on concrete blocks. The seed was surface disinfested for 20 min. in 20% chlorox plus 0.15% Triton X-100 and 10 seeds planted in each of two rows in each crock of soil. Each crock was thinned to 1 plant in test 1 and to 2 in test 2 and 3, 4 weeks later. The design was completely randomized with 25 replications for each treatment in tests 1 and 2 and 45 for test 3.

In test 1, three soils found free of the sugarbeet nematode were selected and designated as soils 1, 2, and 3. The soil type and cropping sequence of each soil is given in table I. One-half of each soil was steam treated for 7 hrs. at 5 lbs. pressure. The final soil treatments were: 1) steam-treated soil, 2) steam-treated soil to which 24,600 partially surface disinfested nematode larvae were added at the rate of 1,000, 2,000, 4,000, 8,000, and 9,600 each succeeding week for 5 wks. following planting, 3) field soil, and 4) field soil plus nematodes at the same rate as treatment 2. The nematode larvae for the inoculations were hatched and partially surface disinfested (4).

For tests 2 and 3, sugarbeet nematode larvae and A. cochlioides were added to non-agricultural soil (loamy sand) to establish the four treatments: 1) control, 2) nematode, 3) A. cochlioides, and 4) a complex of the two organisms. Twenty-thousand larvae were added to each soil at the base of each planting. Two, 3, 4, 5, and 6 thousand larvae were added each succeeding week for five wks. A. cochlioides zoospores were mixed with the soil just prior to placing it in the crocks. Thirty-five and 28 zoospores per g. of soil were added in tests 2 and 3, respectively. Zoospores were obtained by the method of Schneider (2).

Approximately 145 days after planting, beets were harvested, weighed, checked for sprangled roots and soil samples taken. A bioassay of soil samples in test 1 was accomplished by planting surface disinfested seed in each soil and plants damping-off assayed by the water culture method. A bioassay of soil 3 from the original site was also

assayed for pathogenic fungi as described above. Cysts from 10, 100 g. samples were washed from each soil and counted with the aid of a dissecting microscope. Percent sucrose was determined for 10 and 20 replications for tests 2 and 3 respectively.

#### Results:

In all three tests the losses due to the complex of A. cochlioides and H. schachtii were more than additive, however, statistically no interaction was shown, table II and III. This was partially due to the large variation in replicates within treatments. The percent loss of the complex exceeded the combined losses of each alone by 9.4%, 6.9%, and 4.1% for tests 1, 2, and 3, respectively.

The number of sprangled roots in the complex exceeded the total of the nematode plus fungus in test 1 and 2, but not in test 3, table II and III.

A reduction in percent sucrose resulted in test 2 from the complex only and in test 3 for A. cochlioides and the complex, table III.

Bioassays of soil samples from test 1 showed that Pythium ultimum predominated in soils 1 and 2 with equal amounts of P. ultimum and A. cochlioides found in soil 3, table IV. The bioassay of fallowed soil from the original site showed A. cochlioides to be the **predominant** pathogen, table IV.

Nematode reproduction based on the number of cysts recovered from 100 g. of soil was variable, but in all tests the mean number of nematode cysts per g. of tap root was less in the complex than nematode alone, table V.

#### Discussion:

The data suggest that in test 1 soil 3, the main losses were from A. cochlioides and will be discussed with test 2 and 3. Although statistically a synergistic effect due to nematodes and A. cochlioides was not shown, it seems more than coincidental that the losses in all three tests due to the complex were greater than the sum of the losses of each alone. Also, that under some conditions sprangling of roots (test 1 and 2) caused by the complex were more than additive as well as losses in percent sucrose (test 2). This suggests an interaction between H. schachtii and A. cochlioides on sugarbeet.

The effect of P. ultimum is difficult to assess from these data as there was no effect in soil 1, but in soil 2 because of an increase in yield in the nematode treatment it indicates a more than additive loss by the complex of H. schachtii plus P. ultimum.

Table I. Soil type and cropping sequence for each soil.

Soil	Soil Type	Cropping sequence				
		1965	1964	1963	1962	1956
1	Camphora sandy clay loam	Nasturtiums	Barley	Beets	----	----
2	Chualar sandy loam	Barley/vetch	Fallow	Barley	Fallow	Beets
3	Camphora sandy clay loam	Beets	Beans	Barley	Beets	----





Table III. The effects of H. schachtlii, A. cochlionioides and complex of the two on sugarbeet.

	1968				LSD .05	1969				LSD .05
	treatments					treatments				
	1 <sup>a</sup>	2	3	4		1	2	3	4	
$\bar{x}$ yield/rep <sup>b</sup>	387.7	386.3	158.2	131.4	37.9	618.5	611.4	491.3	458.1	51.6
% loss of wt.	-----	0.0	59.2	66.1	-----	-----	1.2	20.6	25.9	-----
No. sprangled roots/total	0/50	2/50	3/45	11/44	-----	4/90	3/90	2/89	4/88	-----
% sprangled	0.0	4.0	6.7	25.0	-----	4.4	3.3	2.3	4.6	-----
% sucrose	14.76 <sup>c</sup>	15.11	14.88	13.57	1.01	12.73	12.53	11.82	12.11	.59
$\bar{x}$ no. cysts/ 100 g. of soil	-----	194.0 <sup>d</sup>	-----	21.5	38.5	-----	50.4	-----	28.4	20.7

<sup>a</sup> 1. Non-agricultural soil, 2. Nematode, 3. A. cochlionioides, 4. Nematode plus A. cochlionioides

<sup>b</sup> 25 replications in 1968, 45 replications in 1969

<sup>c</sup> Mean of 10 replications in 1968 and 20 in 1969

<sup>d</sup> Mean of 10/100 g. samples

Table IV. The total number of sugarbeets damping-off, number and percent from each cause.

Soil	Total	<u>P. ultimum</u>		<u>A. cochlioides</u>		Unknown	
1 <sup>a</sup>	89	77	86.5%	5	5.6%	7	7.9%
2 <sup>a</sup>	100	87	87.0%	5	5.0%	8	8.0%
3 <sup>a</sup>	163	85	52.1%	78	47.9%	0	0.0%
3 <sup>b</sup>	54	9	16.7%	41	75.9%	4	7.4%

<sup>a</sup> Soil from crocks

<sup>b</sup> Soil from the original site

Table V. The effect of A. cochlioides and other organisms in reducing nematode reproduction based on cysts per gram of tap root.

	Test				
	1 (soil 3)		2		3
	nema.	nema. plus fungus	nema.	nema. plus fungus	nema. plus fungus
$\bar{x}$ yield of root g.	120.5	58.3	386.3	131.4	458.1
$\bar{x}$ no. cysts/ crock	7,196	322	27,160	3,010	3,976
cysts / g. of root	59.7	5.5	70.3	22.9	8.7



THE EFFECT OF HETERODERA SCHACHTII, APHANOMYCES COCHLIOIDES AND  
COMPLEXES OF THE TWO AT VARIOUS LEVELS ON SUGARBEET

E. D. Whitney and D. L. Doney

In this report (preceding paper) evidence is presented which suggests a synergistic effect between Heterodera schachtii Schm. and Aphanomyces cochlioides Drechs. on sugarbeet. To evaluate this possibility two factorial experiments were conducted.

Materials and methods:

The two experiments differed in the A. cochlioides inoculum levels and the time of year conducted (winter and spring vs. summer and fall). The A. cochlioides levels were 0, 5, and 50 zoospores per gram of soil in test 1 and 0, .05, and 0.5 in test 2. One fungal inoculation was made. The nematode levels added as larvae were 0, .4, 2, and 10 per gram of soil. The larvae were added each week at increasing rates in a ratio of 2:3:4:5:6 larvae per week for 5 weeks. The initial nematode inoculations at the time the zoospores were added were 0, 80, 400, and 2,000 larvae per 6 in pot of autoclaved loamy sand (approximately 2,000 g.).

Sugarbeet (hybrid F58-554H-1) were thinned to 1 plant per pot 10 days after planting and inoculations began 4 weeks after planting. Prior to the initial inoculation potted plants were placed in temperature control devices "beds" which maintained the soil temperature between 19 and 24 C. The top of the soil and above ground plant parts were exposed to fluctuating greenhouse temperature. Plants were watered (400 ml) when the surface of the soil appeared dry. Five months following planting, plants were individually harvested, weighed, soil from pots with living plants sampled for cysts (100 g. oven dried) and sucrose analysis run (test 2). The treatments were completely randomized within beds with 8 replicates per bed. In test 1 three beds were used while in test 2 two beds were used.

Results:

No synergistic effects between H. schachtii and A. cochlioides on sugarbeet occurred as measured by yield or sucrose, nor did the fungus have a direct effect on the nematode, table 1. An interaction between the nematode and the fungus did occur. This was expressed in the losses in yield and percent sucrose of the complex being less than the sum of the effects of each alone, table 1. An effect on nematode reproduction resulted with the population build-up significantly greater in test 1, table 1. The greatest population of cysts resulted from the addition of 2 larvae per gram of soil, with the cyst population resulting from .4 and 10 larvae per gram of soil being no different at harvest time. There was a highly significant correlation between yield and sucrose percentage and yield and nematode population of .800 and .797, respectively. Of the 16 plants in test 2 inoculated with the low fungal

level (.05 zoospores/g. soil) or with the complex (.4 larvae/g. soil plus .05 zoospores/g. soil) 2 and 4 plants, respectively failed to become infected with the fungus. Plants inoculated with the fungus with or without the nematode at the other levels of inoculum became infected. There was no difference between tests or between beds within tests for comparable yield data.

#### Discussion:

These data do not support the hypothesis that a synergistic interaction occurs between A. cochlioides and H. schachtii on sugarbeet suggesting that the differences were due to large variation within treatments or a more complex interaction between the nematode, fungus and other soil factors in the previous test. The interaction between the nematode and the fungus expressed in losses in yield being less than the sum of the losses of each alone is undoubtedly due to the smaller population of nematodes developing under fungal conditions. This interaction suggests that the fungus predominated, therefore, the nematode effects were small when the fungus potential was high, test 1. This is further supported by the fact that in test 2 a nematode effect on yield resulted under low fungus potential (.05 and .5 zoospores/g. of soil) and medium and high nematode potentials (2.0 and 10.0 larvae/g. soil).

As is well known, nematode populations are determined to a large degree on available nutrients and inoculum potential when environmental conditions are favorable. The high correlation between yield and nematode population shows that the reduction in nematode population is due to lack of nutrients and not to a detrimental effect of the fungus directly on the nematode.

The high correlation between yield and sucrose indicates that the stress caused by the nematode and fungus in reducing yield subsequently reduced sucrose.

Of interest is the observation that under low fungus potential without nematodes or at low inoculum potential of the nematode some plants did not become infected while at the higher nematode potentials all plants were infected. This suggests that the nematode may predispose sugarbeets to infection when the fungus potential in the soil is low.

These data show that under low nematode inoculum potential H. schachtii does not cause sprangling of roots but does increase sprangling under some conditions.

The data strongly suggest that interactions do exist but are greatly influenced by conditions that are not easily determined, therefore, some emphasis should be placed on rotations that would reduce pathogenic fungi as well as the nematode and particularly in soils with low nematode inoculum potentials.

It appears that the rate of nematode reproduction in A. cochlioides infested soils is reduced when used to grow sugarbeets. This effect was not noted in steam-treated soil (3).

Literature cited:

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3. Whitney, E. D. and D. L. Doney 1969. The effect of various levels of Heterodera schachtii and Aphanomyces cochlioides and combinations of both on yield, sucrose and nematode population. Sugarbeet research 1969 report.
4. Whitney, E. D. and D. L. Doney 1970. Large scale hatching, disinfestation and storage of Heterodera schachtii larvae. (In press Phytopathology 60:).

Table 1. The effects of Aphanomyces cochlioides and Heterodera schachtii on sugarbeet.

Larvae/g. soil	Zoospores/g. of soil				
	Test 2	Test 1	Test 2	Test 1	Test 1
	0	0	0.05 0.5	5.0	50.0
0 $\bar{x}$ yld. g.	143.6	140.2	54.6	10.6	5.7
cysts/g. soil	0	0	0	0	0
% sucrose	14.9	-----	12.6	-----	---
0.4 $\bar{x}$ yld. g.	105.5	113.6	49.2	8.4	8.1
cysts/g. soil	808.9	946.2	467.1	121.8	97.8
% sucrose	14.5	-----	13.6	-----	---
2.0 $\bar{x}$ yld. g.	69.5	77.9	33.5	7.9	2.7
cysts/g. soil	935.1	1,321.3	543.6	301.4	189.7
% sucrose	12.6	-----	11.8	-----	---
10.0 $\bar{x}$ yld. g.	47.0	49.5	16.7	5.0	.4
cysts/g. soil	793.0	1,125.8	506.7	293.0	169.0
% sucrose	10.0	-----	9.0	-----	---



# NEMATOLOGY INVESTIGATIONS - 1969

Arnold E. Steele

## The Influence of Depth of Application on the Efficacies of Soil Nematicides for Controlling Heterodera schachtii.

The experiment was located at Jansen Ranch off Esperanza Road near Chualar, California; soil type of the field was clay loam. Pre-treatment sampling revealed a range of 28 to 154 cysts with viable contents with an average of 46 cysts per sample in a total of 10 samples.

Treatments were replicated 3 times and arranged in a randomized complete block design and consisted of Telone or D-D soil fumigant applied on the plot at rates equivalent to 30 gallon per acre. Nemagon was applied at 20 gallon per acre. Nematicides were injected 8 or 18 inches below the soil surface with injector shanks spaced 12 inches apart. Each plot consisted of 60 rows spaced 16 inches apart on 2 acres of land. Broccoli was planted 11 days after treatment. Forty-three days after planting, 20 broccoli plants were selected at random from each plot and removed to the laboratory where the plants were weighed and the roots stained in a boiling solution of Lacto-phenol and acid fuchsin. The stained roots were fragmented in a blender and the debris examined for sugarbeet nematode. Data on plant weights, nematode counts and yields listed in tables 1, 2, 3, and 4 were analysed for statistical significance.

All treatments significantly lowered field populations of the sugarbeet nematode. Although there were no significant differences between chemicals or depths of placement, deep placement of D-D or Telone appeared to control nematode more effectively than shallow applications of these nematicides. Plant weights taken early in the season were not significantly different but at harvest significantly higher yields were obtained from plots treated with deep applications of D-D or Telone.

Table 1. Influence of Nematicides on Control of H. schachtii on Broccoli.

Treatment	Replications			Total	Average
	1	2	3		
D-D 18"	157	70	60	287	95.7
Telone 18"	143	95	41	279	93.0
D-D 8"	99	101	126	326	108.7
Telone 8"	215	59	105	379	126.3
Nemagon 8"	215	261	45	521	173.7
Check	611	477	495	1,583	527.7
Total	1,440	1,063	872	3,375	.
Significance					**
LSD .05					105.0

<sup>1/</sup> Includes adult males, adult females and larvae of H. schachtii recovered from 20 broccoli plants 54 days after treatment and 43 days after planting.

Table 2. Influence of Nematicides on Growth of Broccoli.

Treatment	Replications			Total
	1	2	3	
D-D 18"	13.0 <sup>1/</sup>	12.3	19.6	44.9
Telone 18"	14.0	11.5	10.5	36.0
D-D 8"	12.3	13.5	10.0	35.8
Telone 8"	13.0	11.8	17.9	42.7
Nemagon 8"	12.3	11.8	7.8	31.9
Check	11.4	9.6	7.7	28.7
Total	76.0	70.5	73.5	220.0
				NS

<sup>1/</sup>Total root weight (gms) of 20 plants sampled from each plot 54 days after treatment and 43 days after planting.

Table 3. Influence of Nematicides on Weight of Broccoli Plants.

Treatments	Replications			Total	Average
	1	2	3		
D-D 18"	188.2 <sup>1/</sup>	200.8	179.5	568.5	187.5
Telone 18"	221.5	201.4	153.2	576.1	192.0
D-D 8"	204.5	212.5	174.2	591.2	197.1
Telone 8"	228.9	193.8	176.3	599.0	199.7
Nemagon 8"	179.3	168.8	123.8	471.9	157.3
Check	124.7	153.5	121.6	399.8	133.3
Total	1,147.1	1,130.8	928.6	3,206.5	
Significance					**
LSD .05					22.7

<sup>1/</sup>Total weight (gms) of 20 plants sampled from each plot 54 days after treatment and 43 days after planting.

Table 4. Influence of nematicides on yields of broccoli<sup>1/</sup>

Treatment	Harvest Period						
	1st	2nd	3rd	4th	5th	6th <sup>2/</sup>	7th <sup>2/</sup>
D-D 18"	7,875	9,250	8,875	4,250	2,250	10,250	4,000
Telone 18"	6,750	8,500	9,375	7,875	2,875	13,000	3,500
D-D 8"	7,250	7,125	8,750	3,750	1,875	8,875	3,750
Telone 8"	5,625	6,875	8,500	4,500	2,375	7,750	3,500
Nemagon 8"	4,875	8,375	9,875	5,000	2,000	8,625	3,500
Check	3,750	6,250	9,250	6,625	2,875	7,250	3,500
Significance							*
LSD .05							6,242

<sup>1/</sup> yields given in pounds per plot.

<sup>2/</sup> yields of shoots in pounds per plot.

Reproduction of Heterodera schachtii on Resistant and  
Susceptible Cultivars of Lycopersicon esculentum.

The tomato cultivar, Nematex is resistant to infection with Meloidogyne incognita. Other workers have shown that exogenously supplied cytokinins or high temperatures shifted the response of resistant Nematex toward the susceptible reaction. A project to test the effects of cytokinins and temperature on the susceptibility of tomato to Heterodera schachtii was initiated. This report summarizes results of initial efforts to evaluate the effects of continuous association on resistance of Nematex to Heterodera schachtii. Two tests were conducted.

In the first test, 15 whole cysts obtained from sugarbeet or Pearson A-1 tomato were inoculated on each of 10 tomato seedlings of varieties Pearson A-1 or Y-91 (Nematex). Five plants of each treatment were removed from the greenhouse 33 or 63 days after inoculation and examined by methods described in this report for larvae and adult sugarbeet nematode. Data of this test appear in table 5.

The methods used in a second test repeated those of the first test except 15 broken cysts were inoculated and the nematode populations and sampling dates differed as noted in table 6.

Results of both tests demonstrated that initially, Y-91 is more resistant to sugarbeet nematode than is Pearson A-1 and that both cultivars of tomato support higher nematode populations if the inoculum is obtained from tomato rather than sugarbeet. The second test demonstrated that nematode populations from Y-91 were more infective on Y-91 than were populations of nematode from Pearson A-1.

Cytokinins and high temperatures will be tested for their effects on the host-parasite relationship of tomato and the sugarbeet nematode.



Table 5. Influence of penetration and development of *H. schachtii* on growth of tomato varieties.

Tomato variety	Weight (grams)		Total	Nematode population	Larvae	Mature females	Mature males	Brown cysts	Total Nematodes
	Top	Roots							
1/ 15 days									
Pearson A-1	2.7	1.6	4.3	Tom. Pop. P. A-1	146	6	1	1	154
Y-91	4.7	1.8	6.5	" "	8	1	0	0	9
Y-91	2.8	.8	3.6	Beet Pop. 1962	1	0	0	0	1
Y-91	3.2	1.2	4.4	Beet Pop. 1968	4	0	0	0	4
Y-91	2.4	1.4	3.8	Y-91 - 1968	62	2	0	0	64
2/ 30 days									
Pearson A-1	42.2	25.9	68.1	Tom. Pop. P. A-1	453	195	31	1	680
Y-91	16.0	5.1	21.1	" "	21	10	2	1	34
Y-91	19.6	10.9	30.5	Beet Pop 1962	1	0	0	0	1
Y-91	14.6	6.8	21.4	Beet Pop 1968	1	0	0	0	1
Y-91	32.0	24.8	56.8	Y-91 - 1968	72	32	2	0	106
1/ 60 days									
Pearson A-1	108.1	59.5	167.6	Tom. Pop. P. A-1	1,280	134	12	41	1,467
Y-91	94.8	87.9	182.7	" "	307	1	0	0	308
Y-91	104.0	76.7	180.7	Beet Pop. 1962	0	1	0	0	1
Y-91	113.1	98.5	211.6	Beet Pop. 1968	1	3	0	0	4
Y-91	91.9	87.0	178.9	Y-91 - 1968	597	36	0	73	706

1/ Each figure is data from 3 tomato plants.

2/ Each figure is data from 4 tomato plants.

Table 6. Penetration and development of H. schachtii on tomato varieties<sup>1/</sup>

Tomato Variety	Nematode Population <sup>2/</sup>	Larvae	White female	Viable cysts	Empty cysts	Mature male	Total <sup>3/</sup>
33 days							
Pearson A-1	Tomato	665	281	39	25	33	979
Y-91	"	263	50	45	25	24	337
Pearson A-1	Beet	125	4	49	25	5	134
Y-91	"	45	2	52	23	4	51
63 days							
Pearson A-1	Tomato		2,441	38	28	13	2,454
Y-91	"		725	157	47	0	725
Pearson A-1	Beet		69	34	12	0	69
Y-91	"		1	53	19	0	1

<sup>1/</sup> Data obtained from 5 plants.

<sup>2/</sup> Nematode inoculum obtained from tomato or sugarbeet.

<sup>3/</sup> Does not include cysts. At 33 days numbers of cysts recovered amounted to less than the numbers of cysts inoculated.

# The Influence of Constant and Alternating Temperatures on Hatching and Emergence of Larvae from Cysts of Heterodera schachtii.

In 1953 and 1955 Bishop reported that the rate of emergence of larvae from cysts of Heterodera rostochiensis increased with alternating temperatures. Wallace, 1955 reported similar effects for H. schachtii when cysts were exposed to 24° C for 8 hours and 15° C for 16 hours for 5 days per week. In tests at Salinas, California constant temperatures gave about the same hatch as alternating temperatures.

In order to measure hatches occurring during various times of the day, a device was designed to automatically collect hatches of larvae accumulated during six 4-hour periods in each 24 hours. This consisted of adapting certain components of a Stevens water level recorder. A small motor geared down to less than 1/3 RPM was used to move a ladder chain and an attached rod in a horizontal direction. Four plastic sieves with nylon mesh cloth were attached to the rod so that they were partially immersed in trays containing sugarbeet root diffusate. At 4-hour intervals a time clock activated the motor and a heating element of a thermal relay with normally closed contacts. By inserting a rheostat in series with the heater element of the relay the distance traveled by the sieves could be controlled. The larvae hatched within the sieves, worked their way through the mesh and into small containers positioned directly below the sieves. Upon completion of a 24-hour cycle the traverse rod and sieves were manually returned to the starting position and fresh diffusate added to the trays. Four tests, each with 4 replications, were conducted at constant temperatures of 24° C in a high humidity chamber. In 2 tests each replication consisted of 40 cysts while in 2 tests an equal number of cysts were broken open.

Data from each test revealed that there was a significant difference between the highest and lowest values and that these occurred 12 hours apart suggesting a diurnal periodicity in hatching. However, the effect did not occur during the same 4-hour period in all tests (Table 7), and the cyclic effect was very pronounced with whole cysts but less pronounced with broken cysts.

Table 7. Mean Hatch of 4 Tests - 640 Cysts

Data by time intervals						LSD .05
AM			PM			
4	8	12	4	8	12	
6,500	6,150	5,260	5,340	6,600	6,910	NS
Data by consecutive intervals						1,890
1	2	3	4	5	6	
7,560	6,360	5,560	4,170	6,120	6,980	

To determine whether or not the effect might be the result of changing environmental factors during incubation, a second apparatus was designed to permit collection of larvae emerged from cysts at hourly intervals.

This consisted of certain parts of discarded Technicon fraction collector which was modified by adding an additional motor, cams, micro switches and a stepping relay. A circuit was designed so that alternate contacts of the stepping relay were closed each time the relay coil was energized by a time clock or a micro switch.

Six tests were conducted using this apparatus to collect larvae emerged from eggs or cysts at hourly intervals. Each test was not replicated but 40 or 50 cysts were incubated 15 days either at a constant temperature of 24° C or at alternating temperatures in which the cysts were daily exposed to 8 hours at 24° C and 16 hours at 15° C. Counts of larval hatches were combined for each 4-hour period and listed in table 8.

Of the 4 tests conducted at a constant temperature of 24° C, only the test in which eggs were used (test D) appeared to have a diurnal cycling of the hatch rate. This strongly suggests that cyclic variation in hatching is probably due to a periodic variation in components of the environment, i.e. degradation of hatch factor, accumulation of hatch-inhibiting materials, or alternation of the O<sub>2</sub> to CO<sub>2</sub> ratio.

In both tests wherein cysts were exposed to alternating temperatures, increasing the temperature from 15° C to 24° C resulted in an initial increase in hatch rate that was not sustained during the next 4-hour period of 24° C. A sudden depression of the temperature from 24° C to 15° C effected a sudden decrease in the hatch rate. However, during consecutive periods at 15° C there was a gradual increase in the hatch rate to a maximum below that occurring at 24° C. As the data indicate, hatches at constant temperatures far exceeded those at alternating temperatures.



Table 8. Influence of constant and alternating temperatures on hatching and emergence of larvae from cysts of H. schachtlii<sup>1/</sup>

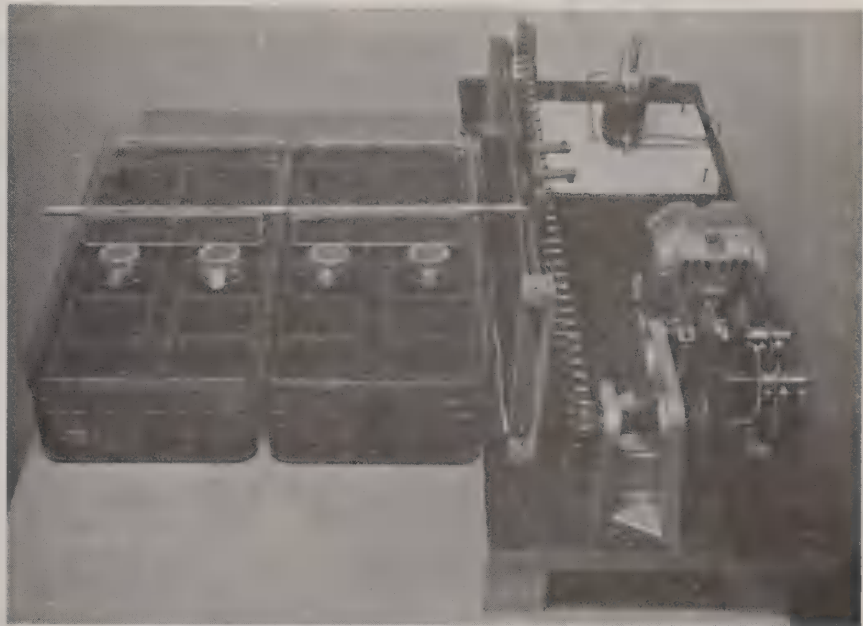
Test	Treatment	Consecutive 4-hour period						Total	Beet <sup>2/</sup> Diffusate	Tap <sup>2/</sup> H <sub>2</sub> O
		1	2	3	4	5	6			
Constant temperatures										
A	50 Cysts	1,073	1,091	993	1,095	1,401	1,241	6,894	8,998	545
B	50 Cysts	1,275	1,501	1,368	1,452	1,487	1,209	8,292	9,501	2,377
C	50 Cysts	1,410	1,536	1,569	1,724	1,740	1,518	9,497	13,314	952
D	Egg clumps from 40 cysts	724	872	646	418	395	609	3,664	8,368	273
Alternating temperatures										
		24° C		15° C				Alt. <sup>4/</sup> Temp. <sup>4/</sup> Const. <sup>4/</sup> 24° C		
E <sup>3/</sup>	40 Cysts	813	425	160	228	322	357	2,305	3,520	14,814
F <sup>3/</sup>	40 Cysts	461	319	108	111	136	146	1,281	1,195	11,515

<sup>1/</sup>All tests conducted for periods of 15 days.

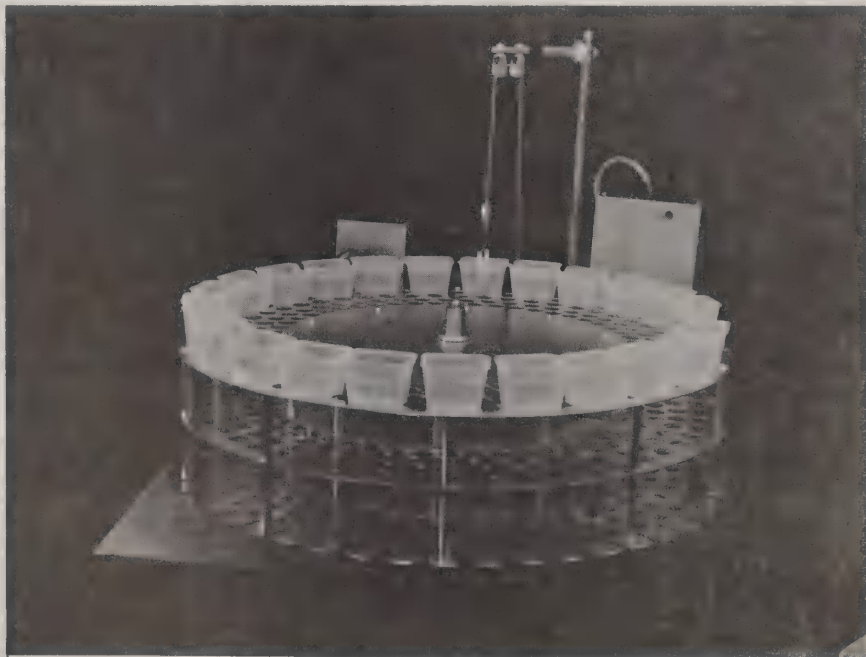
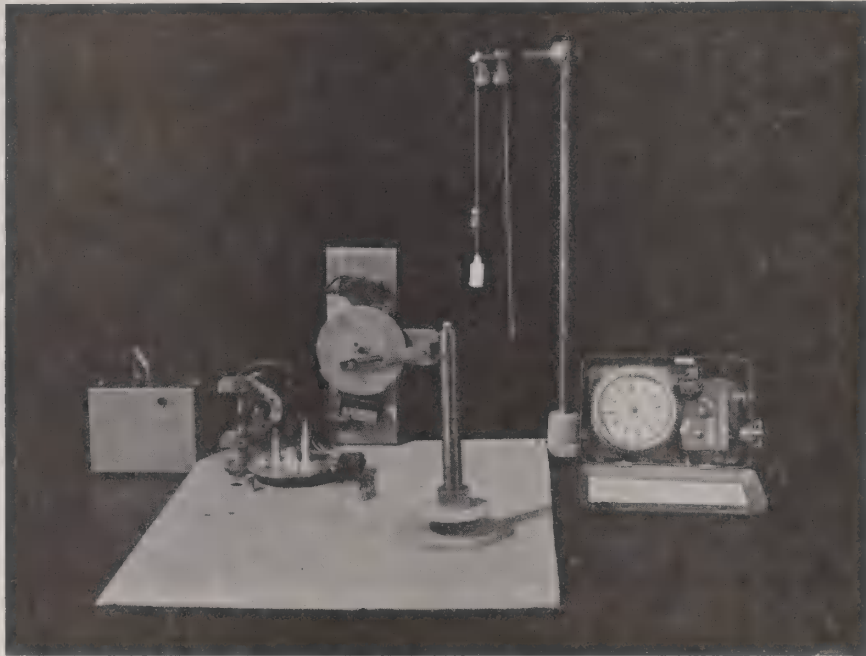
<sup>2/</sup>Cysts or eggs incubated in Syrucuse watch glasses; solutions changed at 5 day intervals.

<sup>3/</sup>Cysts not stored at 10° C before treatment.

<sup>4/</sup>Treated with sugarbeet root diffusate.



Figures 1 and 2. Apparatus used to collect larvae hatched during six 4-hour periods daily for 14 days.



Figures 3 and 4. Apparatus designed to automatically collect hourly hatches of nematode larvae.

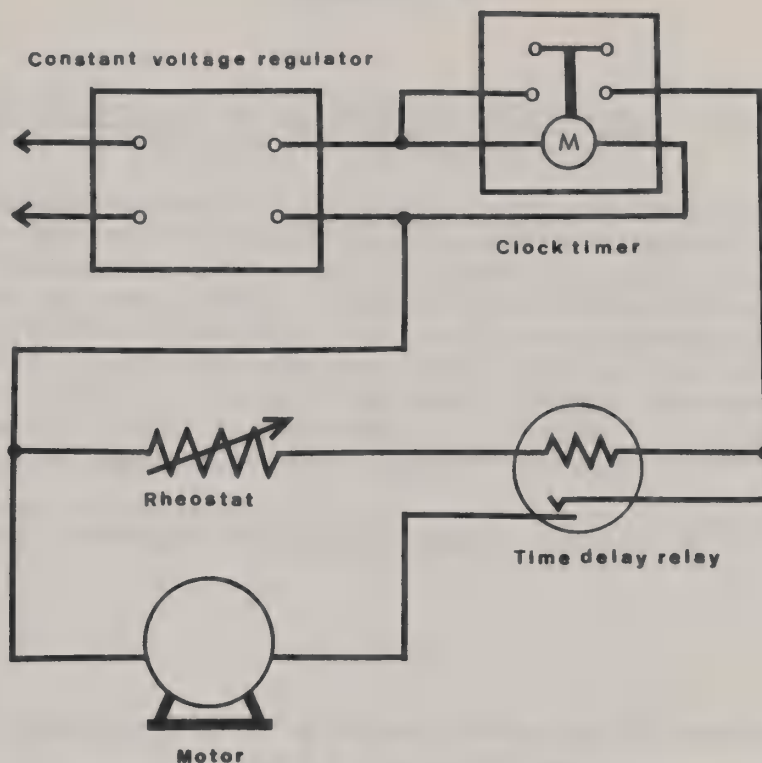


Figure 5. Circuit diagram of apparatus used to collect larvae hatched during 4-hour intervals.

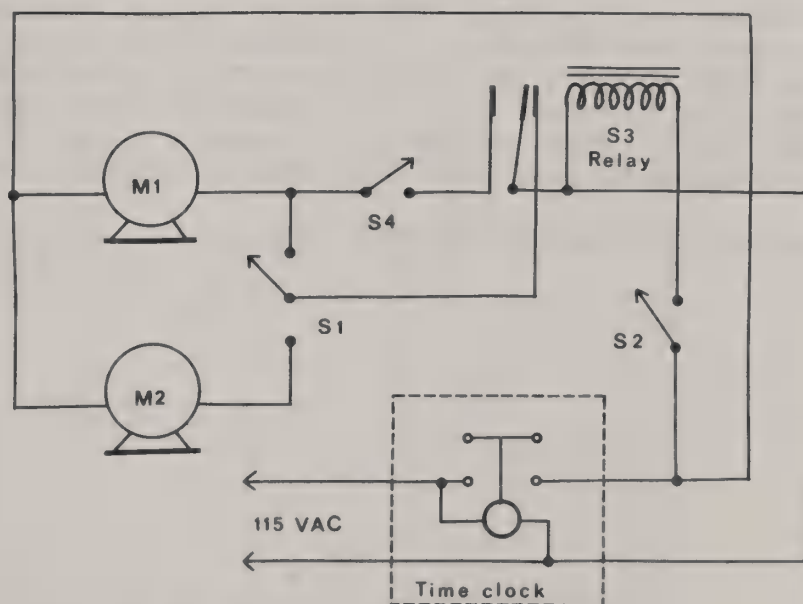


Figure 6. Circuit diagram of apparatus used to collect larvae at hourly intervals during a period of 2 weeks.



Infection of Lycopersicon esculentum and Heterodera schachtii  
by a Phycomycete-type Fungus.

A population of Heterodera schachtii has been maintained in the greenhouse on Pearson A-1 tomato by continuous reinoculation since 1960. In 1969 a fungus which is probably a Phycomycete was found to occur on and within growing tomato roots and newly formed cysts of the sugarbeet nematode. Cooperative investigations to isolate, identify, and grow this fungus on nutrient agar media have been initiated. In addition, a test to determine whether or not the fungus from tomato or the sugarbeet nematode will "reinfect" the nematode, or tomato in the absence of the nematode is in progress. Figures 7-12; photographs of fungus.

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Cooperator: E. D. Whitney, Plant Pathologist, Sugarbeet Investigations.

Influence of Fallow on Decline of Soil Populations  
of Heterodera schachtii.

A study to determine the decline of Heterodera schachtii in fallowed soil exposed to the mild climate of the Salinas Valley of California was initiated in 1962. Sugarbeets were inoculated with Heterodera schachtii and grown in microplots for 2, 4, 6, 9, or 12 months. Beets were harvested on October 2, 1963. Soil from each of 25 plots was sampled at harvest and every year thereafter. The samples were oven dried at 50° C, processed to recover cysts, and counts made of (1) cysts full of viable eggs, (2) partially evacuated cysts with some viable eggs, and (3) cysts devoid of any viable larvae or eggs. The counts of cysts in samples obtained from microplots each year since 1962 are listed in table 9.

This project will be terminated in 1970.

Table 9. Influence of fallow on decline of Heterodera schachtii<sup>1/</sup>

Year	Months elapsed	No. empty	No. full	No. viable	Total no. viable	Total no.	% viable	% Decline of viable cysts <sup>2/</sup>
1963 <sup>2/</sup>	0	1,420	1,703	1,327	3,030	4,450	68.0	-
1964	12	1,535	1,180	890	2,070	3,605	57.4	31.7
1965	24	2,080	453	873	1,326	3,406	38.9	35.9
1966	36	1,783	100	1,267	1,367	3,150	42.5	0
1967	48	82	0	26	26	108	24.0	98.0
1968	60	91	0	10	10	101	10.0	61.5
1969	72	85	0	5	5	90	5.4	50.0

<sup>1/</sup> Number of nematodes per 500 grams of soil. Each figure represents 25 plots.

<sup>2/</sup> Samples obtained on October 3 of each year.

<sup>3/</sup> Percent of population of preceding year.



Figure 7. Phycomycete extruding from the vaginal opening of an adult sugarbeet nematode.

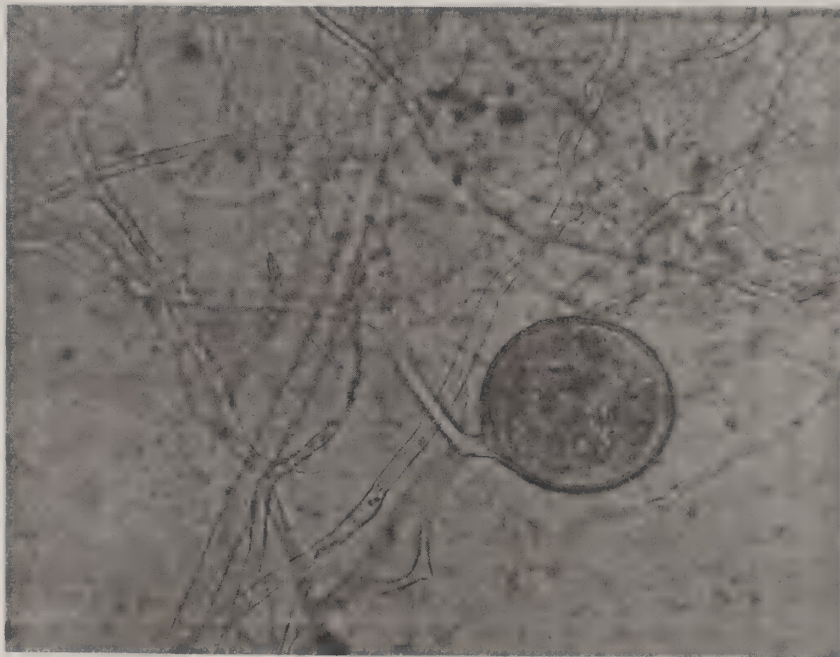


Figure 8. Mycelia and sporangia of ■ Phycomycete removed from tomato roots.



Figure 9. Tomato root infected with a Phycomycete and a mature female sugarbeet nematode.

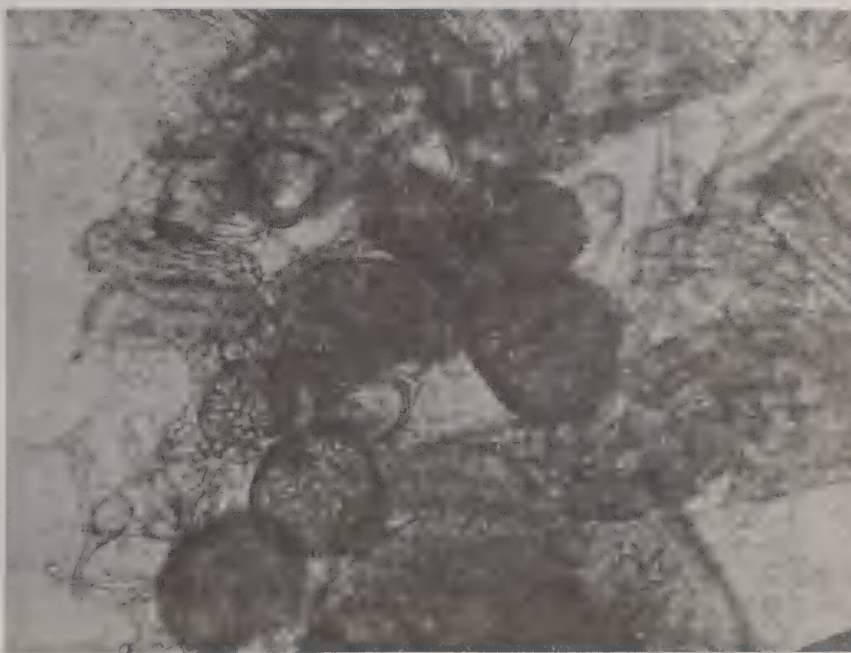


Figure 10. Debris from ruptured cyst of the sugarbeet nematode showing nematode eggs, mycelia, and sporangia of a Phycomycete.



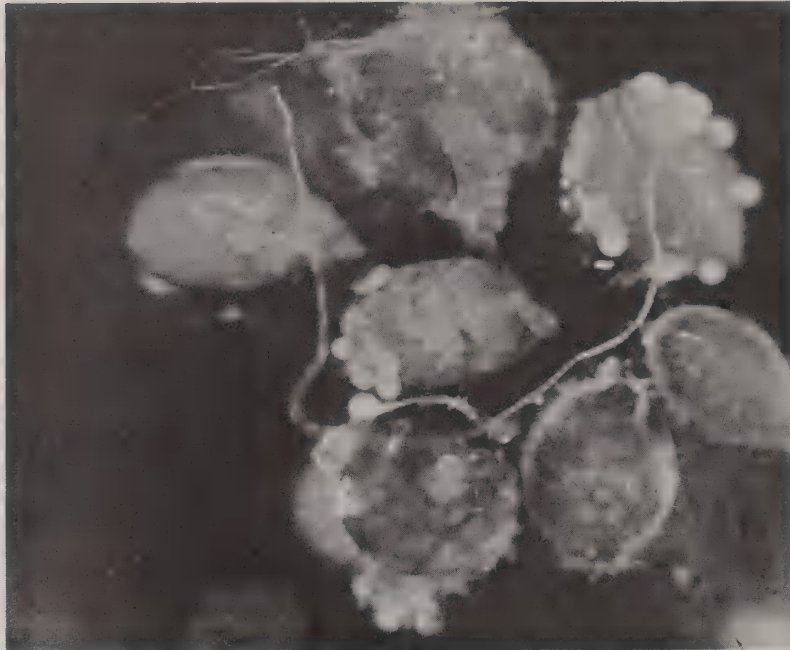


Figure 11. Cysts of H. schachtii infected with Phycomycete.



Figure 12. Roots of Lycopersicon esculentum infected with Phycomycete.

## INTERSPECIFIC HYBRIDIZATION

### VULGARIS-PROCUMBENS HYBRIDS

Helen Savitsky

Transmission of an alien chromosome to another species is of great theoretical and practical importance. The chromosome of B. procumbens responsible for nematode resistance was transferred from  $3n$   $F_1$  hybrids to the  $b_1$  generation. The irregularities of meiosis in Vulgaris-Patellares hybrids make the transmission of chromosomes of Patellares species to the following hybrid generations difficult. Of 6,750  $b_1$  hybrids, only 4 highly nematode resistant plants were selected, which produced a sufficient quantity of seed. They had an additional 19th chromosome; apparently the chromosome of B. procumbens, which was responsible for nematode resistance.

The first  $b_1$  nematode resistant trisomics, selected 3 years ago, were severely infected by virus yellow and produced very little viable seed. Two highly resistant but almost sterile plants having 19 chromosomes, were obtained in the  $b_2$  progeny of one of these hybrids ( $b_1$  N 3742). In the  $b_3$  generation, 2 highly resistant trisomics were again selected. One of these  $b_3$  hybrids did not transmit the nematode resistance to the next generation, whereas several resistant plants were obtained in  $b_4$  generation from the other trisomic.

Three new highly nematode resistant  $b_1$  trisomics (NN 4651, 4264, and 4678) were selected during the following years. Although they were semi-fertile, they produced a sufficient quantity of seed. Resistant  $b_2$  plants were selected in the progeny of each of these  $b_1$  hybrids. In such a way a population consisting of 57 nematode resistant  $b_2$  and  $b_4$  hybrids was obtained for the first time (Table 1). All the plants selected had either no cysts on the roots in 3 tests, or from 1 to 4 cysts on the roots in 1 of 3 tests. The resistant plants had a well developed root system, fleshy roots and resembled sugarbeet, not the wild species. Besides nematode resistance, some of the  $b_2$  and  $b_4$  hybrids inherited from B. procumbens the tendency to bolt and to produce tumors.

Frequency of resistance transmission to the next generation varied in the individual trisomics from 7 to 13 percent. But it is possible that some trisomics may not transmit the resistance, as it was observed in one  $b_3$  hybrid.

Table 1... Frequency of transmission of nematode resistance to the progeny of

resistant trisomics

Generation	b <sub>1</sub> N 3742(2n = 19)	b <sub>1</sub> N 4651(2n = 19)	b <sub>1</sub> N 4264(2n = 19)	b <sub>1</sub> N 4678(2n = 19)
	Resistant plants selected	Resistant plants selected	Resistant plants selected	Resistant plants selected
	Number    Percent	Number    Percent	Number    Percent	Number    Percent
b <sub>2</sub>	2 (2n 19)	17        13.59	11        10.38	5        7.58
b <sub>3</sub>	2 (2n 19)			
b <sub>4</sub>	24        12.15			



Fig. 1 Cysts free root system of  $b_2$  nematode  
resistant vulgaris-procumbens hybrids.





Fig. 2 vulgaris-procumbens b<sub>2</sub> nematode resistant hybrids



Fig. 3 Different morphological types of vulgaris-corolliflora b<sub>3</sub> hybrids resistant to curly top virus.

Examination of chromosome number in the plants of the resistant population revealed that this population contained many trisomics ( $2n = 19$ ). Also, some new resistant plants appeared which had 18 chromosomes. Apparently such diploid hybrids arose in the consequence of crossing over, or translocation between the chromosomes of different species in the  $b_3$  or in the preceding hybrid generations.

The population of resistant hybrids represents very important material from which it is intended to obtain stable highly nematode resistant lines. In accordance with the chromosome set in the individual plants, different methods (X-Ray irradiation, hybridization, etc.) will be applied, together with cytological studies and selection for resistance to achieve this goal.

Some new problems have to be studied at this new phase of work. The inheritance of nematode resistance is not known (how many genes are responsible for the high grade of resistance), how easily the segments of B. procumbens chromosome will be transmitted to the following generations, etc. It is known only that resistance to nematode is a dominant character (Savitsky and Price, 1964). Solutions of these problems is inevitable for development of nematode resistant lines and the population obtained represents a basic material for future progress.

#### VULGARIS-COROLLIFLORA HYBRIDS

Helen Savitsky and C. W. Bennett

The  $b_2$  of Beta vulgaris-corolliflora hybrids highly resistant to curly top virus were previously selected by Dr. Bennett. The resistant hybrids were vigorous plants, but they produced almost no normal pollen and were pollinated by diploid sugarbeet. Seed setting was different in the individual  $b_2$  plants. Many plants exhibited different degrees of sterility. Seed harvested from these hybrids have been planted and 150  $b_3$  hybrids were grown from them. The young plants were inoculated at the 12-leaf stage by using a virulent strain of curly top virus (Strain 11- N. J. Giddings). Inoculations were made by caging 20 viruliferous leafhoppers, in 4 lots of 5 each, on each plant and allowing them to feed for a period of ten days. After the plants were inoculated they were incubated in a greenhouse for a period of about three months. During this period they were graded with respect to symptoms and at the end of the period all plants which had

shown no symptoms were reinoculated as described above. Two months after reinoculation the final selection was done. Thirty-six highly resistant hybrids which showed no curly top symptoms were selected in this group. Forty-eight plants were slightly susceptible and showed mild vein swelling. Thirty-nine hybrids were susceptible - their leaves began to curl, and 27 plants were very susceptible dwarf plants with curled leaves. Some of these died (Table 2).

The  $b_2$  plants selected for curly top resistance belong to different morphological types obviously caused by different chromosomes acquired from the wild species. Transmission of resistance to curly top virus in B. vulgaris-corolliflora hybrids is due to the B. corolliflora univalents responsible for resistance. In such a way a new source of curly top resistance is transferred to B. vulgaris.

In the preceding  $b_2$  generation the chromosome number varied in the resistant hybrids from 20 to 25; the majority of the plants had 22 chromosomes (18 B. vulgaris and 4 B. corolliflora chromosomes). It is desirable to decrease, as much as possible, the number of B. corolliflora chromosomes in the following generations; and to maintain only those chromosomes of wild species which are responsible for the high grade of curly top resistance.

A decrease of B. corolliflora chromosomes is to be expected in the  $b_3$  hybrid generation because of the loss of some B. corolliflora univalents. In comparison with the  $b_2$  generation the chromosome number actually decreased in the selected curly top resistant  $b_3$  hybrids. The number of chromosomes varied in these hybrids from 18 to 23; the majority of plants had 19 or 20 chromosomes. Some resistant hybrids had 18 chromosomes. Apparently such plants had the segments of B. corolliflora chromosomes which were incorporated by crossing over or translocations into B. vulgaris chromosomes.

The diploid curly top resistant hybrids, as well as the hybrids having only 1 or 2 additional chromosomes of wild species represent a very important material for obtaining highly curly top resistant diploid lines. At the same time the reduction in the number of B. corolliflora chromosomes offers a certain danger of their possible loss in the following generation. Therefore, intensive investigations should be carried out in the  $b_3$  and  $b_4$  hybrid generations.

Table 2 ... Distribution of b<sub>3</sub> Beta vulgaris x Beta corolliflora hybrids  
accordingly to the grade of curly top resistance

Degree of resistance	Number of plants
Highly resistant	36
Slightly susceptible	48
Susceptible	39
Very susceptible	27
Total	150



X-Ray irradiation should be applied to some plants having 19 and 20 chromosomes depending on the degree of their male and female fertility. A further selection for resistance accompanied by cytological studies is necessary for development of diploid lines highly resistant to curly top virus.

#### EFFECT OF X-RAY IRRADIATION ON MEIOSIS IN SUGARBEET

X-Ray irradiation is often used in interspecific hybridization to induce chromosome breakage. It is highly possible that it will be necessary to apply irradiation in vulgaris-Patellares and in vulgaris-corolliflora hybrids at a certain stage of work. The effective roentgen doses which should be applied at meiosis in beet are not known. To study the effectiveness of R-doses, sugarbeet plants were irradiated at the Lawrence Radiation Laboratory in Berkeley. The roentgens, 500, 800, 1,000, 1,200, and 1,500 were applied to the young floral axes. Irradiation buds were fixed in aceto-alcohol solution (1:3) 3 hours and 4-5, 7-8, and 10 days after irradiation. The smears of anthers stained by orcein and the sectioned buds stained by iron-hemateixylin were studied cytologically.

A study of meiosis revealed that in irradiated plants not all buds, not all anthers, and not all pollen mother cells within the anther were affected by X-Rays. In some anthers meiosis in many PMCs was disturbed by irradiation. But for the most part, meiosis was affected in only 10 to 30 percent of the PMCs, whereas in the other PMCs of the same anther meiosis proceeded normally.

No changes of meiosis were observed after irradiation by 500 roentgens. Irradiation by 800 and 1,000 roentgens showed similar effects. At the first and second metaphase, interkinesis, and first telophase, one or two chromosomes or fragments of chromosomes were often observed lying in the cytoplasm. Anaphase bridges and slowly moving lagging chromosomes were observed on the spindle. Pollen mother cells at tetrad stage contained 5, 6, or 7 nuclei instead of 4. Some pollen grains having 2 membranes - intine and exine - were empty and shriveled. Such irregularities of meiosis indicate that breakage and reunion of chromosomes took place in the affected PMCs. Some translocated chromosomes which had no partners for association were thrown into the cytoplasm. Chromosomes having structural changes were later oriented on the equatorial plates and were lagging on the spindle at the anaphase. Bridges were formed after reunion of broken

ends of chromosomes. The pentads, hexads, etc. arose in consequence of irregular chromosome distribution caused by structural changes.

The same disturbances at meiosis were observed after irradiation by 1,200 and 1,500 roentgens. But the pollen grains were damaged more severely by the stronger doses of roentgens. In PMCs affected by 1,200 and by 1,500 roentgens, very young pollen grains newly discharged from the tetrads were very small, of irregular shape and almost all empty. Pollen grains having 2 membranes often did not separate from each other, but were kept in groups. The roentgen 1,500 was especially harmful. Pollen grains were often killed by this dose. They were of irregular shape, often broken, and their nuclei were darkly stained. Such pollen grains had no turgor. They adhered all together in piles in the anthers, and often could not be pressed out by smears from the anthers. The anthers were limp and not filled out.

The described breaks at meiosis were observed in the buds fixed 4-5 and 7-8 days after irradiation. Ten days after irradiation by any roentgen dose the outline of meiosis was usually normal. This indicated that the buds in the PMCs of which meiosis took place 10 days after irradiation, were developed after exposure to X-Rays, and their PMCs or generative tissues were not affected by X-Rays.

The abnormalities of meiosis observed several days after irradiation occurred in PMCs which were affected by X-Rays at premeiotic stages. PMCs at meiosis are more sensitive to irradiation and the damage caused by it is much greater than at premeiosis. Radiation during meiosis leads to squeezing of the cytoplasm, of spindle fibers, and of chromosomes in PMCs. Sometimes it results in complete destruction of generative tissues in the anthers. Very young pollen grains newly discharged from the tetrads are also very sensitive and are often killed by X-Rays.

A cytological study of irradiated sugarbeet floral axes lead to the following conclusions: (1) the 800 and 1,000 roentgens are the most suitable for irradiation of the young floral axes. Chromosome breakage and translocations were induced in some pollen mother cells by these roentgen doses. Larger doses of 1,200 and 1,500 roentgens induced translocation but were harmful and caused a high degree of pollen sterility. (2) The generative cells at premeiosis are less sensitive than the PMCs at meiosis to the deleterious effect of irradiation. Therefore, irradiation of the young buds in all stages of development is more preferable than irradiation of buds at meiosis.

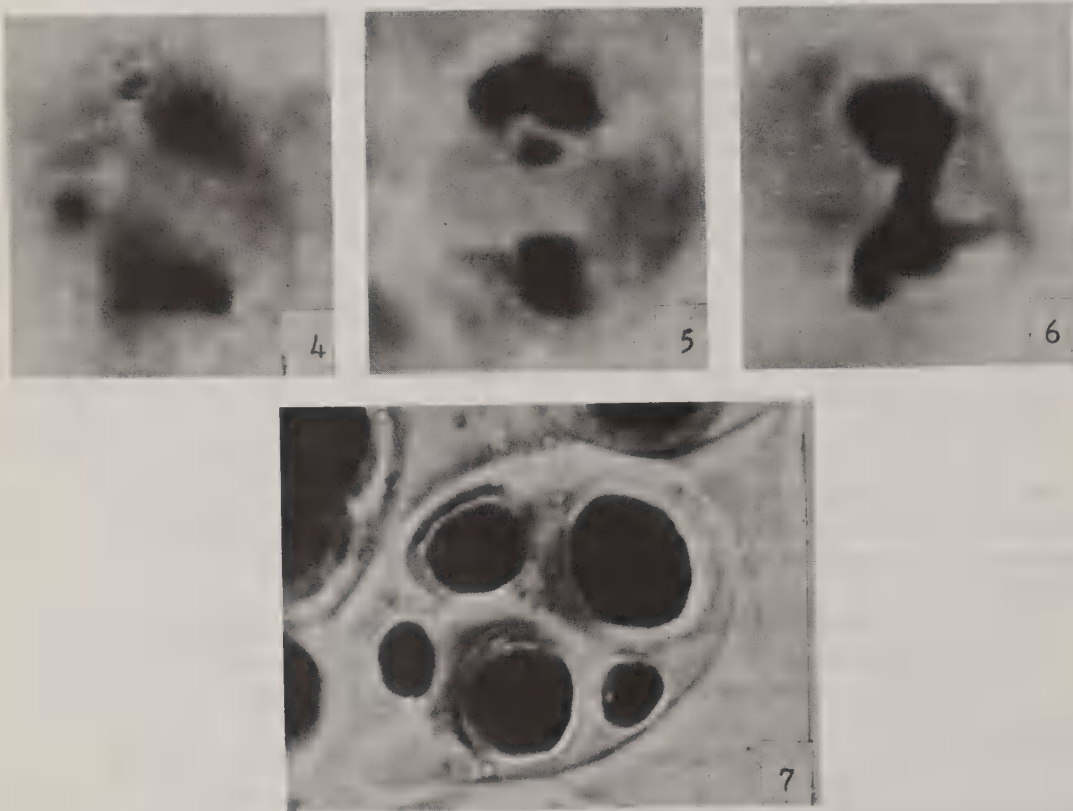


Fig. 4-7 Meiosis in X-Ray irradiated sugarbeets

Fig. 4 First telophase with 2 chromosomes thrown into cytoplasm

Fig. 5 Second metaphase with a chromosome in the cytoplasm

Fig. 6 Anaphase bridge

Fig. 7 Pentad in pollen mother cell



(3) Meiotic disturbances caused by X-Ray irradiation could be observed 8-10 days after irradiation. Therefore, if it is desirable to induce translocation on a larger scale, irradiation should be repeated in 10-12 days, providing suitable buds are available.

### STUDIES IN POLYPLOIDY

Helen Savitsky

Investigations of the viability of  $3n$  seed developed on diploid and on tetraploid male-sterile plants were started in 1968 and continued in 1969.

Twenty-seven plants of diploid male-sterile line 91 and 81 plants of diploid male-sterile line 129 were bagged in the greenhouse and pollinated by the pollen of tetraploid multigerm and monogerm self-sterile beets. Correspondingly, 35 plants of tetraploid male-sterile line 91, 28 plants of tetraploid male-sterile line 129, and 33 plants of tetraploid male-sterile line 8546-36-H2T were pollinated by the pollen of diploid multigerm and monogerm beets.

Seed harvested were tested for germination and ovule development. For germination, seed were washed for 3 hours, then put between 2 layers of wet blotting paper and placed in the oven. Temperature of  $68^{\circ}$  F. was maintained for 16 hours and  $86^{\circ}$  F. for 8 hours. Sprouts were counted in 3, 7, and 10 days.

Ovules were analyzed in 50 fruits per plant. The ovules having white starch were considered to be normal. The shriveled and empty ovules were regarded as aborted.

In diploid male-sterile lines, ovules were examined in 5076 fruits and 5,400 fruits were tested for germination. In tetraploid male-sterile lines, ovules were examined in 4,518 fruits and 4,800 fruits were tested for germination (Table 3). The percent aborted ovules was very close in 3 diploid male-sterile populations (from 24.73 to 26.53); whereas in one population of the line 91, the percent of aborted ovules was lower (19.71) (Table 3).

The tetraploid male-sterile lines had a slightly higher average percent of aborted ovules (29.73) than the diploid



Table 3... Ovule development and fruit germination in triploid matings - 2n male-sterile lines x 4n pollinators and 4n male-sterile lines x 2n pollinators

Matings	Fruits (ovules) examined	Ovules per 50 fruits		Fruits tested for germination		Sprouts per 50 fruits	
		Normal	Aborted	Number	Percent	Number	Percent
2n 91 MS x 4n mm	700	562	138	19.71	800	418	52.25
2n 129 MS x 4n mm	1,150	858	292	25.39	1,200	537	44.75
2n 91 MS x 4n MM	550	414	136	24.73	550	332	60.36
2n 129 MS x 4n MM	2,676	1,966	710	26.53	2,850	1,288	45.19
Total	5,076	3,800	1,276	25.14	5,400	2,575	47.69
4n 91 MS x 2n MM	1,700	1,211	489	28.76	1,750	1,009	57.66
4n 129 MS x 2n mm	1,343	918	425	31.65	1,400	502	35.86
4n 8546-36-H2T x 2n MM	1,475	1,046	429	29.08	1,650	655	39.70
Total	4,518	3,175	1,343	29.73	4,800	2,166	45.13

t calculated for aborted ovules in 2n and in 4n male-sterile lines = 2.22

t tabulated at 0.05 0.01  
1.987 2.632

t calculated for sprouts obtained in 2n and in 4n male-sterile lines = 0.70

t tabulated at 0.05 0.01  
1.984 2.626

lines (25.14). The larger value of  $t$  calculated than the value of  $t$  tabulated at 0.05 indicated the significance of difference.

The percent germination in  $3n$  fruits developed on diploid male-sterile lines varied from 44.75 to 60.36. Percent germination in  $3n$  fruits developed on tetraploid male-sterile lines varied from 39.70 to 57.66. The average percent of germination in  $3n$  fruits harvested on diploid plants (47.69) was close to the average percent germination in  $3n$  fruits from tetraploid plants (45.13). The value of  $t$  calculated indicated no significant difference.

A large variability in vitality of fruits was observed within diploid and tetraploid male-sterile lines. All male-sterile lines (diploid and tetraploid) contained some plants in which almost all ovules were normally developed with fruit germination between 80 and 90 percent. Whereas some other plants in the same line had many aborted ovules and germination of their fruits was very poor. Such plants with low fruit viability decrease the average evaluation of the lines. The individual populations of the same male-sterile line may exhibit different degrees of fruit viability depending upon the occasional composition of plants differing in fruit vitality.

These experiments confirmed the results obtained last year, that the contemporary tetraploid male-sterile lines (which are at the same time inbreds) when used as female parents for production of  $3n$  seed, do not show an advantage in fruit viability in comparison with the diploid male-sterile lines.

The inviability of fruits in some male-sterile plants is apparently caused by the deleterious effect of some homozygous genes in inbred lines. The diploid as well as tetraploid male-sterile lines and their equivalent pollinators should be improved by selection of plants higher in fruit viability.



# SUGARBEET RESEARCH

1969 Report

## Section C

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Variety Tests, Logan, Utah, 1969

George K. Ryser and J. C. Theurer

SOIL TYPES: Silty loam on North Farm and sandy loam on Farmington Farm.

PREVIOUS CROPS: 1967-1968 alfalfa at the North Farm, potatoes in 1968 on the Farmington Farm.

FERTILIZER: Both farms received 400 pounds per acre of 24-20-0, harrowed in before planting.

PLANTING DATES: North Farm was planted May 7, 1969. Farmington Farm was planted April 14, 1969.

THINNING DATES: North Farm June 2, 3, 1969, Farmington Farm, May 13, 1969.

IRRIGATIONS: North Farm sprinkled after planting. Sprinkled after thinning and on a weekly schedule until two weeks before harvest. Farmington, furrow irrigated approximately at weekly intervals as needed to keep field on the damp side throughout the season until two weeks before harvest.

HARVEST DATES AND PROCEDURES: North Logan tests were harvested October 8 to 15, 1969. Farmington tests were harvested October 27 to 30, 1969.

Tops were removed with a rotobeaater and scalped with tractor-mounted scalping tools supplemented by long-handled hoe trimming to assure a complete topping job. Beets in plots were counted when put into the weighing basket on the harvester. A ten-beet sample was taken at random from the harvester table from each row of the two-row plots for sugar analysis, and all beets in the plot were weighed to determine root yield.

EXPERIMENTAL DESIGN: Test 1 planted at the North Farm, Logan, Utah, consisted of 64 entries in an 8 X 8 balanced lattice of nine replications and analyzed as a randomized block design.

Test 2 was planted at Farmington, Utah, and consisted of 49 entries planted in a 7 X 7 balanced lattice design but analyzed as a randomized block design.

Test 3 was planted at the North Farm in randomized block design with 22 inbred entries and four replications.

Test 4 was planted on the North Farm in four-row plots with four entries in paired comparisons of transplant versus seed planting. This was analyzed as a 4 X 2 factorial in randomized blocks with six replications.

Test 5 was a single variety treated with three different seed additives and an untreated control planted on the North Farm in six replications of a randomized block design.

Test 6 was made up of 96 hybrids planted in randomized block design with six replications at Farmington, Utah.

Tests 7, 8, 9, and 10 were individual beet progeny selections with 18, 11, 7, and 21 entries, respectively, each planted in a randomized block design with six replications.

Test 11 was a paired comparison of four pollinator inbreds and their equivalent CMS inbreds in a split-plot randomized block design of six replications.

#### Variety Test 1

This test was established to evaluate the relative yield performance, sugar percentage, and impurity index of 60 experimental single-cross hybrids. Comparison was also made with four check varieties, two of which were commercially adapted single-cross hybrids. One was a commercial three-way hybrid and the other check was US 22/3. Means, standard errors, and F values are given in Table 1.

Eight varieties were higher in gross sugar than the best check, a commercial single cross, and 15 exceeded the three-way hybrid. The two highest yielding lines (SLC 133 CMS X 0198 S and L-53 CMS X 0198 S) both had the same male parent. These lines, however, were not significantly better than 14 other experimental varieties or the two highest yielding checks. Sugar percentage was low this year, averaging only 12.5%. This, no doubt, was due mainly to environmental conditions at Logan during the growing season.

It is evident that L-19 shows excellent combining ability for sugar percentage since all hybrids with this line were among the top 10 in the test for this character. Four single crosses (Codes 53, 54, 55, and 60) significantly exceeded the best check variety in sugar percentage.

Twenty-three hybrids had a lower impurity index value than the commercial varieties, however, none of these were significantly better in quality than the best check (a single-cross commercial).



A good example of specific combining ability is demonstrated for hybrids having L-53 as a parent. The range of the hybrids involving this inbred was from 3784 to 6373 lbs/acre gross sugar and a sugar percentage of 11.38 to 13.86%.

#### Variety Test 2

This experimental test was planted at Farmington, Utah, and consisted of 48 of the same entries as were in variety test 1, including the four check varieties. An experimental three-way hybrid (7114) that had shown high yield in previous years' variety trials was also included as a check in this test.

A highly significant difference between locations and variety X location was evident (Tables 1 and 2). The yield of beets and sugar percentage were higher and the impurity index was lower than noted for the same varieties at Logan. This difference can be mainly attributed to the five-week longer growing season at Farmington.

The two highest yielding varieties at Logan were, respectively, 8th and 28th at Farmington. The third highest yielding variety at Logan had the largest gross sugar at Farmington.

The leaf-spot pollinator, EL 66P21, showed good combining ability for high yield at Farmington (Table 2). The entry having the highest gross sugar was not significantly better than 13 other entries, three of which were check varieties (Codes 17, 43, 44).

The three hybrids having L-19 as a parent were the highest in sugar percentage again at this location. These data suggest that L-19 should have good potential use for increasing sugar percentage in hybrids. However, the single crosses with this line have been only average in yield of gross sugar due to low tonnage. Other hybrids with good sugar percentage had SLC 133 as a parent (Codes 7, 10, 20). Seven hybrids (Codes 7, 10, 20, 24, 39, 40, 49) were significantly higher in sugar than the best commercial hybrid or the old open-pollinated variety US 22/3.

Single crosses with L-53 as a parent had a high impurity index at Farmington as well as at Logan. None of the entries were significantly better in quality than the best check variety (Code 44).

#### Variety Test 3

Test 3 was an inbred yield trial for 22 entries and was grown at Logan, Utah. Gross sugar ranged from 918 lbs/acre to 5,740 lb/acre (Table 3). An inbred selection from Ovana and SLC 129 lines was highest in yield. EL 31 was lowest in yield, but this line was severely infected with curly-top disease, resulting in a poor stand and small beets at harvest. Lines coded 14, 8, and 16 also had poor stands in the field.

L-19 was significantly the highest in sugar percentage, exceeding all other inbreds for this character with the exception of Ovana 2. Line 130 CTR (Code 20) was lowest in sugar percentage. This line is a sister line to L-35 which was released in 1969 as a high curly-top resistant inbred.

A wide variation in impurities was noted. Lines 12, 10, and 6 were highest in impurity index, while lines 13 and 5 were lowest in impurities. The 0461 sugar selection 246 and 0198 sugar selection 323 were extremely high in amino N. High Na inbreds were 0198 sugar selection 404 and line 28.19. Inbreds high in K were: Am. Crystal 64-11, 22.005, 33.m', and 0198 sugar selections 323, 327, 335, and 404.

#### Variety Test 4

It is well known that much of the sugarbeet acreage in Japan is transplanted rather than directly seeded to the field. Interest has generated in areas of the northwest regarding the possibility of transplanting in this country. If such a method is practicable, it would be beneficial to an area like Logan, where the growing season is so short. This year we designed a small test to evaluate the performance of four entries: an inbred, an open-pollinated variety, a single cross, and a four-way restorer hybrid.

#### METHODS

The four lines were seeded the first week of April to 3 cm X 10 cm Japanese paper pots in large wooden trays in the greenhouse. Gro-lux lamps were utilized to hasten development, so the seedlings were in the 4-6 true leaf stage by May. The field was marked with stakes according to a randomized plan for four-row plots with paired plots of transplant versus seeding side by side in each of the six replicates. Seeding was accomplished May 7 with our six-row experimental drill. The drill was also used to mark the plots for transplanting. May 8 and 9 seedlings from the flats were individually placed by hand 12 inches apart down each plot row. After transplanting, the field was soaked good by sprinkler irrigation.

The two center rows of each plot were harvested and the two border rows of each plot were discarded. Otherwise the beets were handled as indicated at the beginning of this report.

#### RESULTS

The transplanted plots showed more rapid growth and a larger canopy of foliage than the seeded plots until about September 1. Thereafter, there was little difference in the appearance of the foliage of the two types of planting for each entry. Roots from transplanted units were

short and stubby and the sprangled root portions tended to be broken off at harvest. Seeded beets, conversely, had smooth and well-shaped roots (Figure 1).

The yield of gross sugar and tons per acre was significantly higher for the transplanted plots with the exception of the four-way hybrid (Table 4A). No difference was observed between transplant versus seeded beets for sugar percentage or impurity index. The impurity components of amino N, Na, and K also showed similar values for each entry regardless of the planting method (Table 4B).

The increase in tonnage was the only apparent advantage for transplanting and it is doubtful that the weight increase would offset the cost of transplanting on a commercial scale. The transplants had a significantly better stand at harvest than the seeded plots (Table 4B). Therefore, it is possible that this could be a major factor in higher yield for the transplants in this test.

#### Variety Test 5

Experiments at Utah State University, as well as other locations, have demonstrated a beneficial effect of rapid germination from treating tomato seeds with various substances prior to planting. This experiment was established in the greenhouse and in the field to observe whether or not sugarbeet germination could be accelerated and what effect this might have on the stand, yield, and sugar percentage of sugarbeets.

#### MATERIALS AND METHODS

Monogerm seed of an experimental hybrid (Logan #8100) was screened, hand picked, and counted to provide a uniform seedlot for use in these experiments.

The first experiment was conducted in a seed germinator. Twenty seeds were placed on a blotter paper in each of 16 petri dishes. Then 3.5 ml of either a 1, 5, or 10% solution of  $\text{KNO}_3 + \text{K}_3\text{PO}_4$ , or distilled water, was added to each petri dish, making four replications of each of the treatments. Germination readings were made 3, 5, 7, and 10 days after treatment.

In a second experiment, seed of the same variety was placed 1/2 inch deep in rows in metal flats in the greenhouse and replicated four times. Seed treatments included dry seed, 1%  $\text{KNO}_3 + \text{K}_3\text{PO}_4$  solution, 5%  $\text{KNO}_3 + \text{K}_3\text{PO}_4$  solution, dry seed covered with pectin, dry seed covered with gelatin, seed soaked three hours in water and surface dried. Seed handled similarly, but rolled in gelatin and in pectin, completed the entries in the study.

The field planting was made at Logan with six replications of the four treatments listed below.



1. Control -- dry seed
2. Seed soaked for 5 minutes in 1%  $\text{KNO}_3 + \text{K}_3\text{PO}_4$  solution, then dried
3. Seed moistened and rolled in cellosize powder
4. Seed moistened and rolled in pectin

## RESULTS

In the first experiment the germination with distilled water was more rapid and more complete than the  $\text{KNO}_3 + \text{K}_3\text{PO}_4$  solutions. The latter showed a decrease in the speed of germination and less total germination with each increase in concentration. This chemical solution, which enhanced tomato seed germination, was detrimental rather than beneficial to sugarbeet. The second study showed very little difference in treatments also.

In the field test no differences were observed in the rate of germination between the treatments. Insignificant differences were also found for gross sugar, tonnage, sugar percent, and impurity factors (Table 5).

## Variety Test 6

The 96 varieties in test 6 were new experimental hybrids, evaluated at Farmington. Only one check, U. I. Hybrid #8, was included in this test. (Table 6)

Highly significant differences were noted for each variable studied. However, this was expected with the large number of entries. Fifty-six hybrids outyielded the commercial check, but only four of them were significantly better in gross sugar. The two highest yielding varieties had 0198 sugar selection 323 as a parent, which was the same pollinator as the one in the best single-cross varieties in test 1. The entries with this inbred also showed above average sugar percentage with a fairly high impurity index value. The combining ability manifest in our limited tests suggest this inbred may be useful to the industry as a commercial pollinator.

EL 66P21 combined well as a pollinator with some of our adapted inbred material to give good yield of roots. Code 55, (129 X L-53) X 22.005, had the highest sugar percentage in the test, being about 2% higher than the mean. All but two of the hybrids having over 17% sugar had L-19 as a parent. This again confirms the potential value of this inbred for increasing sugar percentage in hybrids.

Hybrids with 0198 S (323) showed higher yield than the sister selection 0198 S (335), but the latter had the largest sugar percentage on the average. Likewise, 0461 S (282) was better than its sister selection 0461 S (246) for tons of roots, but 0461 S (246) hybrid had higher sugar.



Three hybrids (Codes 35, 36, and 37) with the inbred pollinator selected from US 35 X Ovana were somewhat disappointing. As an inbred in 1968 tests, this pollinator line appeared to be one meriting consideration for variety improvement. In this test two of the entries with this line were below average in yield and one was about average.

The inbred 29.002 was generally a pollen parent in hybrids having a low-index value, while inbred 133 M<sup>1</sup> was a parent in hybrids with a high impurity index. The two lines with the highest sugar percentage had low impurity indices, but other high-sugar lines tended to have average impurity values.

#### Variety Test 7

Individual beet progeny selections from 0457 (630 aa X CT5) were planted in a randomized block planting with 18 entries in six replications. The test was made to evaluate the merit of individual beet selection based on impurity index. The entries consisted of nine low-index high-sugar selections, eight progenies selected for high index, and the 0457 parent.

The performance of the 18 populations is given in table 7 in order of ascending index value. With two exceptions, codes 10 and 12, the high-index selections were high, and the low-index high-sugar group had low-index values. The parent variety ranked with the low-index group. Selection 4 was significantly lower and 16 was significantly higher than the parent for index. Five high-index selections were significantly lower than the parent in sugar percentage. This demonstrates a good correlation between low index and high-sugar percentage.

#### Variety Test 8

This test represents selections from variety 9229 (Misc. aa mm X Misc. mm) made in 1967 at the North Farm in Logan, Utah. The test was made up of six low-index high-sugar individual beet progenies from Mendelian male-sterile plants only and five high-index individual beet progenies and the parent seed. The test was planted in a randomized block with 12 entries and six replications.

There were three progenies that produced significantly less gross sugar than the parent, codes 5 and 2, low-index high-sugar selections, and code 11, a very high-index selection (Table 8).

The progenies are tabled in ascending order by index value and show that eight selections and the parent (codes 7, 4, 12, 3, 1, 6, 8, 2, and 5) are not significantly different for this character. Of the eight selections, codes 7 and 8 were in the intermediate high-index group. One could expect an occasional line to do this on a random

basis, but code 7, being the lowest index in the test, must have had some contamination in the seed isolation plot or an identity error to be so low in index value. Association of index value and sugar percentage appeared to be quite random in this material.

#### Variety Test 9

This test is similar to tests 7 and 8 with selections from variety 952 (821 mm aa X CT5 mm). There were four low-index high-sugar selections, two high-index selections, and the parent in a randomized block design of six replications.

The correlation between high-sugar and low-index values is evident, but differences in index values were insignificant. The parent variety had the highest gross sugar and the best sugar percentage. (Table 9)

#### Variety Test 10

This impurity index selection test had 13 low-index high-sugar progenies, 7 high-index progenies, and the parent variety in a randomized block of six replications.

In general the ascending order of index measure again tends to group the progenies as to the selection pressure. However, codes 15, 14, and 20, selected for high index, were exceptions since they placed in the low-index high-sugar group in this test. The high-index selections 18 and 19 and the low index selection 11 were significantly inferior to the parent in sugar percent. The parent was also significantly better than codes 3 and 16 for impurity index. (Table 10)

The selection groups were not completely isolated in the seed plots, which may have given rise to the randomness of variation in the two selections.

#### Variety Test 11

Test 11 was designed to compare four  $S_3$  O-type inbreds with their CMS equivalents. The lines were planted in paired plots in a randomized block design with six replications at the North Farm in Logan, Utah.

Highly significant differences were observed for O type versus CMS for each variable studied except Na. The CMS lines showed more seedling vigor than the pollinators. CMS lines, on the average, were high in tonnage and gross sugar, slightly higher in sugar percent, and generally had a higher impurity index value than the pollinators. However, the four lines did not behave similarly for each variable. The pollinators 833 and 0534 were higher in index than their CMS counterparts. The CT9 lines (809) showed the greatest differences

of the four lines tested. This was expected, however, since the CT9 CMS seedlot was contaminated with other pollen. (Tables 11A and 11B)

This test illustrates that the CMS lines are more productive than equivalent pollinators after three generations of inbreeding. However, one observes that the beet count is also significantly different. This suggests that some of the variation may be attributed to this factor alone.

Line 833 (SLC 133) had an extremely high impurity index for both the pollinator and equivalent CMS.

Table 1 . Single-cross variety trial, Logan, Utah, 1969 (64 entries, 9 reps)

Code	Description	Acre Yield		Percent Sugar	Index	Amino N		PPM		K	Beet Count
		Gross Sugar	Tons Beets			N	Na				
20	SLC 133 CMS X 0198 S (323)	6,456	25.00	12.90	887	653	151	1,738	66		
19	L-53 CMS X 0198 S (323)	6,373	25.57	12.45	978	664	125	2,033	68		
16	(SLC 128 X NB-1) X CT5A	6,325	24.87	12.68	600	285	126	1,703	72		
3	NB-1 CMS X SLC 129 Rf	6,325	24.33	12.98	651	387	139	1,639	62		
52	SLC 133 CMS X LSR-CTR Sel'n.	6,305	25.53	12.30	789	447	114	1,909	66		
43	(SLC 128 X NB-1) X CT7	6,184	23.68	13.06	872	330	116	1,503	68		
14	(SLC 129 X C505) X CT5A	6,140	24.95	12.34	636	314	149	1,648	74		
30	L-53 CMS X CT9	6,020	24.82	12.15	690	373	129	1,669	66		
63	U & I Hybrid #7	6,013	24.08	12.50	708	431	139	1,610	72		
29	Am. Cr. 63-5 H0 X CT9	6,006	23.50	12.75	699	424	136	1,679	62		
36	SLC 129 CMS X EL 66P21	5,908	22.78	12.97	595	351	134	1,486	64		
59	308 CMS X CT9A	5,889	25.87	11.38	805	418	209	1,696	64		
53	SLC 129 CMS X L-19	5,854	20.95	13.93	671	454	139	1,735	62		
4	EL 31 CMS X SLC 129 Rf	5,839	21.90	13.33	600	362	141	1,535	64		
60	AI-10 CMS X 0198 (297)	5,783	20.92	13.81	637	449	99	1,581	56		
41	(SLC 129 X C505) X CT7	5,757	21.93	13.13	612	384	119	1,506	72		
61	Amalg. Comm'l	5,744	22.33	12.85	684	457	132	1,522	76		
42	L-53 CMS X 0198 S (335)	5,727	23.83	11.98	933	495	159	2,267	52		
50	L-53 CMS X (SLC 133 X M')	5,699	22.78	12.48	885	522	164	2,099	68		
31	Am. Cr. 63-4 H0 X CT9	5,677	22.50	12.64	619	309	138	1,682	68		
55	L-53 CMS X L-19	5,665	20.42	13.86	709	481	120	1,817	54		
57	1114 CMS X L-19	5,642	21.18	13.32	628	343	155	1,728	64		
1	CT9 CMS X SLC 129 Rf	5,628	21.72	12.96	596	319	130	1,627	70		
11	L-53 CMS X EL 31	5,628	21.93	12.83	752	498	131	1,669	58		
47	L-53 CMS X 0461 S (282)	5,622	22.73	12.36	703	326	185	1,909	64		
21	CT9 CMS X 0198 S (323)	5,621	22.17	12.63	839	507	123	2,024	48		
33	SLC 133 CMS X L-13	5,618	22.22	12.63	718	432	145	1,694	52		



Table 1. continued

Code	Description	Acre Yield		Percent Sugar	Index	Amino N	PPM		Beet Count
		Gross Sugar	Tons Beets				Na	K	
37	CT9 CMS X EL 66P21	5,580	22.57	12.39	606	285	142	1,657	70
5	UI-Misc. SP. C.A. CMS X CT5A	5,518	22.25	12.37	591	254	138	1,716	74
40	L-53 CMS X 29.005	5,485	24.17	11.38	927	446	198	2,117	50
58	308 CMS X EL 32	5,398	25.93	10.46	1,024	431	245	2,172	62
2	L-53 CMS X SLC 129 Rf	5,393	20.90	12.90	659	402	124	1,608	62
17	UI-Misc. SP.C.A. CMS X CT7	5,368	21.70	12.37	613	327	131	1,543	72
22	SLC 133 CMS X (US35 X L-53)	5,351	21.22	12.61	705	436	156	1,553	60
44	L-53 CMS X 22.005	5,324	22.13	12.02	884	481	197	2,035	58
18	L-53 CMS X 28.19	5,315	21.32	12.50	724	413	155	1,722	64
49	SLC 129 CMS X (SLC 133 X M1)	5,270	21.37	12.39	713	364	141	1,857	50
64	U & I Hybrid #8	5,246	20.78	12.59	673	413	153	1,499	62
32	L-53 CMS X L-13	5,218	21.70	12.03	799	396	166	2,020	44
39	SLC 133 CMS X EL 66P21	5,204	21.78	11.96	907	603	178	1,679	72
6	L-53 CMS X 29.002	5,172	21.15	12.18	730	387	159	1,773	58
8	L-53 CMS X SLC 133	5,091	20.93	12.19	886	540	166	1,862	50
51	SLC 129 CMS X LSR-CTR seln.	5,034	21.03	11.99	739	380	122	1,830	54
45	SLC 133 CMS X 22.005	4,951	20.35	12.18	813	494	166	1,743	54
46	CT9 CMS X 0461 S (282)	4,945	20.13	12.27	584	228	163	1,700	65
62	US 22/3	4,888	20.02	12.23	777	423	178	1,822	70
9	Am. Cr. 63-4 H0 X SLC 133	4,884	19.73	12.39	779	430	207	1,831	51
10	Am. Cr. 63-5 H0 X SLC 133	4,884	19.78	12.36	810	513	191	1,673	50
24	L-53 CMS X (US 35 X L-53)	4,865	19.50	12.47	808	535	140	1,675	62
34	L-19 CMS X L-13	4,802	18.00	13.32	640	351	144	1,795	40
38	L-53 CMS X EL 66P21	4,764	20.07	11.88	841	520	164	1,688	58
27	SLC 133 CMS X 0461 S (246)	4,708	18.27	12.86	793	582	192	1,326	56
23	SLC 129 CMS X (US 35 X L-53)	4,688	18.55	12.63	655	390	145	1,535	50
26	L-53 CMS X 0461 S (246)	4,632	18.45	12.58	855	633	164	1,516	60
56	SLC 133 CMS X L-19	4,601	17.33	13.22	755	478	174	1,814	44
48	SLC 133 CMS X 0461 S (282)	4,520	18.80	12.01	659	320	206	1,545	57

Table 1 . continued

Code	Description	Acre Yield		Percent Sugar	Index	Amino N		PPM		Beet Count
		Gross Sugar	Tons Beets			N		Na	K	
12	SLC 133 CMS X EL 31	4,338	17.33	12.51	916	671		157	1,665	40
35	CT 9 CMS X L-13	4,169	16.98	12.27	659	306		130	1,821	35
25	CT9 CMS X 0461 S (246)	3,992	15.35	12.97	649	422		155	1,451	34
7	SLC 133 CMS X 29.002	3,974	15.98	12.43	798	537		134	1,618	40
15	L-53 CMS X Am. Cr. 64-11	3,919	16.38	11.94	836	430		185	1,995	32
13	SLC 129 CMS X Am. Cr. 64-11	3,498	13.68	12.82	657	332		124	1,858	24
28	L-53 CMS X NB-1	3,487	14.52	12.07	874	484		156	1,941	26
54	SLC 128 CMS X L-19	3,248	11.93	13.63	666	428		112	1,749	24
Mean of all varieties		5,268	21.04	12.54	737	429		152	1,736	
S.E. of Mean		228	0.80	0.18	38	32		10	70	
L.S.D. (5 percent point)		644	2.25	0.50	106	90		29	198	
C.V. Percent		12.97	11.37	4.27	15.32	22.33		20.00	12.90	
Calculated F		10.45**	14.26**	10.83**	8.83**	9.54**		7.71**	7.32**	

\*\* Significant at 1% level.

Table 2 . Single-cross variety trial, Farmington, Utah, 1969 (49 entries, 8 reps)

Code	Description	Acre Yield			Percent Sugar	Index	Amino N		PPM		Beet Count
		Gross Sugar	Tons	Beets			N		Na	K	
13	(SLC 128 X NB-1) X CT5A	10,188	32.48		15.17	348	136		186	1,379	76
25	SLC 129 CMS X EL 66P21	10,033	31.11		16.16	364	171		155	1,450	70
26	CT9 CMS X EL 66 P21	10,006	32.15		15.54	365	123		192	1,511	76
43	7114 Check	9,960	32.21		15.47	376	166		219	1,351	66
17	(SLC 129 X C505) X CT5A	9,948	31.59		15.76	362	149		167	1,453	74
28	SLC 133 CMS X EL 66P21	9,920	31.57		15.71	383	184		254	1,309	82
46	U & I Hybrid #7	9,763	31.05		15.72	390	181		238	1,399	66
16	SLC 133 CMS X 0198s (323)	9,742	30.78		15.84	459	277		223	1,484	72
38	SLC 133 CMS X LSR-CTR Sel'n.	9,684	31.23		15.54	426	211		169	1,557	66
33	L-53 CMS X 0461 S (282)	9,602	31.81		15.09	439	150		242	1,712	70
48	SP.C.A. Group X CT5A	9,582	30.40		15.76	329	129		147	1,356	76
44	Amalg. Comm'l	9,486	29.95		15.83	347	154		151	1,373	76
14	L-53 CMS X 28.19	9,339	30.72		15.24	431	207		266	1,419	70
35	SLC 129 CMS X SLC 133 X M'	9,335	28.81		16.19	459	186		342	1,733	60
20	SLC 133 CMS X 0461 S (246)	9,278	27.79		16.70	335	193		180	1,211	66
21	L-53 CMS X CT9	9,168	30.61		14.99	411	172		179	1,523	64
1	CT9 CMS X SLC 129 Rf	9,140	29.30		15.61	403	176		156	1,593	68
9	L-53 CMS X EL 31	9,135	28.37		16.12	369	193		172	1,368	62
22	Am. Cr. 63-4H0 X CT9	9,130	28.43		16.06	319	128		146	1,332	78
47	U & I Hybrid #8	9,051	29.59		15.30	420	196		254	1,429	72
41	308 CMS X CT9A	9,009	30.59		14.72	464	190		265	1,603	72
6	6-53 CMS X SLC 133	8,997	29.26		15.37	461	210		326	1,538	60
42	UI-Misc. SP.C.A. CMS X CT7	8,995	28.45		15.82	334	134		126	1,401	76
34	SLC 133 CMS X 0461 S (282)	8,992	28.58		15.72	377	172		238	1,348	68
49	(SLC 129 X C505) X CT7	8,869	27.23		16.27	327	149		96	1,401	70
37	SLC 129 CMS X LSR-CTR Sel'n.	8,868	28.18		15.72	368	153		133	1,518	58
45	US 22/3	8,835	27.85		15.85	377	160		173	1,506	74
15	L-53 CMS X 0198 S (323)	8,813	28.51		15.46	478	265		170	1,649	66
27	L-53 CMS X EL 66P21	8,808	29.10		15.16	410	200		191	1,406	64
4	L-53 CMS X 29.002	8,752	28.43		15.42	373	153		202	1,404	58

Table 2 . continued

Code	Description	Acre Yield		Percent Sugar	Index	Amino N		PPM		Beet Count
		Gross Sugar	Tons Beets			N	Na	Na	K	
40	L-53 CMS X L-19	8,723	25.75	16.95	370	190	162	1,518		58
39	SLC 129 CMS X L-19	8,719	24.78	17.58	340	153	177	1,533		66
2	L-53 CMS X SLC 129 Rf	8,602	27.35	15.74	379	162	172	1,498		68
23	L-53 CMS X L-13	8,540	28.02	15.26	485	207	249	1,781		46
3	NB-1 CMS X SLC 129 Rf	8,494	27.33	15.57	371	156	175	1,439		58
36	SLC 133 CMS X SLC 133 X M'	8,480	28.06	15.12	469	172	259	1,778		73
8	Am. Cr. 63-5 H0 X SLC 133	8,476	26.25	16.14	371	168	240	1,383		60
29	L-53 CMS X 29.005	8,390	29.30	14.31	540	223	351	1,706		52
31	L-53 CMS X 22.005	8,368	27.79	15.06	468	198	250	1,679		62
30	L-53 CMS X 0198 S (335)	8,221	26.63	15.44	466	195	226	1,784		48
32	SLC 133 CMS X 22.005	8,024	25.40	15.80	409	178	228	1,554		55
24	L-19 CMS X L-13	7,903	23.14	17.10	380	181	146	1,661		68
18	L-53 CMS X CT5A	7,454	23.64	15.77	386	183	168	1,465		68
5	SLC 133 CMS X 29.002	7,370	22.68	16.23	324	164	141	1,249		48
7	Am. Cr. 63-4 H0 X SLC 133	7,251	22.06	16.42	354	153	265	1,341		50
10	SLC 133 CMS X EL 31	7,065	21.38	16.52	360	201	170	1,336		46
12	L-53 CMS X Am. Cr. 64-11	6,983	23.24	15.02	463	197	256	1,638		36
11	SLC 129 CMS X Am. Cr. 64-11	5,457	16.92	16.08	367	149	162	1,536		24
Mean of all varieties		8,792	27.96	15.73	396	179	203	1,489		
S.E. of Mean		303	0.99	0.14	17	15	27	43		
L.S.D. (5 percent point)		856	2.80	0.40	49	42	76	120		
C.V. Percent		9.73	10.00	2.54	12.29	23.51	37.63	8.08		
Calculated F		9.50**	10.93**	18.36**	8.87**	4.89**	4.25**	11.25**		

\*\* Significant at 1% level



Table 3 . Inbred line yield trial Logan, Utah, 1969 (22 entries, 4 reps)

Code	Description	Acre Yield			Percent Sugar	Index	Amino		PPM		Beet Count
		Gross Sugar	Tons Beets				N		Na	K	
19	0v.2	5,740	21.26		13.49	473	217		112	1,529	52
3	SLC 129 CMS	4,574	19.05		12.01	658	342		117	1,635	62
1	SLC 129 Rf	4,059	16.35		12.41	660	352		122	1,702	64
21	0198 Sug (327)	4,022	16.42		12.31	821	455		145	2,008	38
2	SLC 129	3,802	15.49		12.32	628	325		91	1,658	58
11	0464	3,787	15.26		12.41	875	620		120	1,684	62
10	0198 Sug (323)	3,606	15.49		11.64	1,175	828		72	2,059	62
4	22.005	3,493	14.66		11.91	870	481		126	2,038	47
22	0198 Sug (404)	3,465	15.00		11.52	728	289		164	1,964	61
9	28. L-19	3,234	12.82		12.56	624	331		152	1,602	50
17	0198 Sug (335)	3,080	12.15		12.69	724	410		83	1,919	50
20	130 CTR	2,978	13.46		11.34	658	355		65	1,458	66
15	E1 66 P 21	2,977	12.97		11.46	854	493		115	1,783	54
14	27. L-53	2,681	11.10		12.05	819	518		99	1,729	28
18	L-19	2,394	8.59		13.95	749	608		97	1,612	44
6	33. M1	2,235	9.34		11.92	1,053	736		141	1,873	56
13	0461 Sug (282)	2,121	8.55		12.40	538	205		117	1,687	44
5	29.002	1,991	8.25		12.10	525	251		92	1,412	36
12	0461 Sug (246)	1,887	7.72		12.17	1,212	1,089		134	1,361	46
8	Am. Cr. 64-11	1,590	6.56		12.07	796	497		130	1,674	26
16	29.005	1,233	5.17		11.94	771	371		96	2,063	26
7	E1 31	918	3.86		11.75	930	718		138	1,286	26
Mean of all varieties											
S. E. of Mean											
L.S.D. (5 percent point)											
C.V. Percent											
Calculated F											
		27.38**	27.41**		2.52**	23.58**	31.66**		6.14**	9.30**	

\*\* Significant at 1% level.

Table 4A. Transplants versus seeded yield trial, Logan, Utah, 1969 (8 entries, 6 reps)

Code	Description	Gross Sugar			Tons/acre			Percent Sucrose			Index	
		Seed	Trans	Mean	Seed	Trans	Mean	Seed	Trans	Mean	Seed	Trans
1	US 22/3 (O.P. Variety)	4,553	5,479	5,016	18.25	21.95	20.10	12.45	12.46	12.45	596	713
2	U & I Hybrid #7 (Single Cross)	5,211	5,786	5,499	21.33	23.80	22.56	12.16	12.18	12.17	689	672
3	(AI-1 X L-53)X(SLC128XRf)	5,040	5,239	5,139	19.83	20.78	20.30	12.69	12.62	12.65	573	575
4	(4-way Rf hybrid)	3,355	3,906	3,630	12.80	14.88	13.84	13.10	13.13	13.11	471	565
	5.002 (Inbred)											
	Mean all varieties	4,539	5,002	4,821	18.05	20.35	19.20	12.60	12.59	12.60	582	627
	Sig. Diff 5%:											
	Seed and transplants	513			1.88			NS			NS	
	Varieties			363			1.33			0.45		101

Variance Table

Source of Variation	DF	Gross Sugar		F	Tons/acre		F	Sucrose		F	Index	
		Mean	Square		Mean	Square		Mean	Square		Mean	Square
Replications	5	17.26	X 10 <sup>5</sup>	9.00**	15.71	6.09**	NS	42.49	X 10 <sup>3</sup>	NS	42.49	X 10 <sup>3</sup>
Treatment	1	38.05	X 10 <sup>5</sup>	19.85**	63.48	24.60**	NS	24.75	X 10 <sup>3</sup>	NS	24.75	X 10 <sup>3</sup>
Varieties	3	80.64	X 10 <sup>4</sup>	42.07**	168.33	65.24**	7.14*	61.57	X 10 <sup>3</sup>	4.11*	61.57	X 10 <sup>3</sup>
Treatment X Varieties	3	26.47	X 10 <sup>4</sup>	NS	3.86	NS	NS	15.46	X 10 <sup>3</sup>	NS	15.46	X 10 <sup>3</sup>
Error	35	19.17	X 10 <sup>4</sup>		2.58			14.97	X 10 <sup>3</sup>		14.97	X 10 <sup>3</sup>
Total	47	93.89	X 10 <sup>4</sup>		15.94			17.05	X 10 <sup>3</sup>		17.05	X 10 <sup>3</sup>

\* Significant at 5% level

\*\* Significant at 1% level



**Figure 1. Root shape of seeded beets (upper) versus transplanted beets (lower)**

Table 4B. Transplants versus seeded yield trial, Logan, Utah, 1969 (8 entries, 6 reps)

Code No.	Description	Seed	Amino N Trans	Mean	Seed	Na Trans	Mean	Seed	K Trans	Mean	Seed	Beet Count Trans	Mean
1	US 22/3 (O.P. Variety)	299	393	346	118	129	123	1,602	1,778	1,690	62	66	64
2	U & I Hybrid #7 (Single Cross)	401	372	386	114	114	114	1,566	1,522	1,544	64	66	66
3	(Al-1 X L-53)X(SLC128XRf) (4-way Rf hybrid)	322	333	328	114	107	111	1,458	1,417	1,438	60	66	63
4	5.002 (Inbred)	256	324	290	64	86	75	1,358	1,552	1,455	60	60	60
Mean all varieties													
Sig. Diff 5%:		319	355	337	102	109	106	1,496	1,567	1,532	62	64	63
Seed and transplants		NS		NS		NS		NS		NS		2.3	
Varieties		NS		62		20		NS		NS		1.66	

Variance Table

Source of Variation	D.F.	N Mean Square	F	Na Mean Square	F	K Mean Square	F	Beet Count Mean Square
Replications	5	24.12 X 10 <sup>2</sup>	NS	1419.4	NS	60.19 X 10 <sup>3</sup>	NS	3.47
Treatment	1	15.77 X 10 <sup>3</sup>	NS	540.0	NS	60.71 X 10 <sup>3</sup>	NS	38.52
Varieties	3	19.26 X 10 <sup>3</sup>	3.42*	5393.4	9.02**	15.93 X 10 <sup>3</sup>	NS	14.74
Treatment X Varieties	3	93.83 X 10 <sup>2</sup>	NS	458.0	NS	52.03 X 10 <sup>3</sup>	NS	4.85
Error	35	56.26 X 10 <sup>2</sup>		597.3		60.92 X 10 <sup>3</sup>		4.08
Total	47	66.10 X 10 <sup>2</sup>		980.8		66.55 X 10 <sup>3</sup>		5.48

\* Significant at 5% level

\*\* Significant at 1% level



Table 5. Seed additives variety trial Logan, Utah, 1969 (4 entries, 6 reps)

Code	Description	Acre Yield		Percent Sugar	Index	PPM			Beet Count
		Gross Sugar	Tons Beets			Amino N	Na	K	
2	$\text{KNO}_3 + \text{K}_3\text{PO}_4$ 1% solution	5,522	24.12	11.47	873	396	171	2,171	47
3	Cellulose (damp seed)	5,243	22.72	11.54	867	413	146	2,142	42
1	Control	5,060	21.62	11.71	682	322	114	1,773	42
4	Pectin (damp seed)	4,960	21.70	11.47	864	411	153	2,101	40
Mean of all varieties		5,196	22.54	11.55	822	385	146	2,047	
S.E. of Mean		193	0.93	0.14	52	30	12	127	
L.S.D. (5 percent point)		NS	NS	NS	NS	NS	33	NS	
C.V. Percent		9.09	10.09	2.97	15.40	19.14	19.62	15.19	
Calculated F		NS	NS	NS	NS	NS	4.04*	NS	

\*Significant at 5% level

Table 6. Hybrid variety test, Farmington, Utah, 1969 (96 entries, 6 reps)

Code	Description	Acre Yield			Percent Sugar	Index	Amino N	PPM		Beet Count
		Gross Sugar	Tons Beets					Na	K	
30	7114 X 0198 S (323)	9,569	29.23		16.34	422	246	214	1,466	82
32	(S33 X NB-1) X 0198 S (323)	9,565	29.05		16.47	431	279	190	1,446	73
80	7114 X SLC 133 X M'	9,268	28.05		16.53	372	173	208	1,474	80
84	(S33 X NB-1) X SLC 133 X M'	9,254	28.74		16.10	436	206	226	1,659	70
48	(SLC 129 X Ov.2) X EL 66P21	9,109	28.00		16.27	316	144	196	1,202	81
45	(SLC 133 X 030.5) X EL 66P21	9,022	27.64		16.36	365	173	261	1,312	82
34	(FC 601 X CT5) X 0198S (323)	8,993	27.38		16.45	352	191	142	1,349	72
3	(S33 X Ov.2) X SLC 129 Rf	8,985	28.20		15.97	355	150	225	1,350	70
9	7114 X 29.002	8,961	27.43		16.34	307	149	150	1,204	76
75	(SLC133 X 030.5) X 0461S (282)	8,936	28.31		15.79	380	141	277	1,446	76
46	(S33 X NB-1) X EL 66P21	8,932	27.71		16.13	355	171	231	1,278	68
87	(SLC 133 X CT5) X 27.53	8,860	28.23		15.72	335	152	206	1,211	76
78	(L-53 X CT5B) X SLC 133 X M'	8,859	28.25		15.66	428	172	338	1,517	75
69	(SLC 133 X CT5) X 0461 S (282)	8,854	27.94		15.83	374	178	239	1,325	68
59	(90.68 X SLC 129) X L-19	8,836	25.55		17.27	389	180	207	1,668	68
11	(S33 X Ov.2) X Am Cr 64-11	8,823	28.95		15.26	319	114	302	1,060	61
20	(S33 X CT5) X Am Cr 64-11	8,811	27.56		16.02	350	141	204	1,388	68
93	(SLC 133 X 030) X L-19	8,800	25.45		17.30	385	190	271	1,522	72
31	(EL 31 X 030) X 0198 S (323)	8,790	25.86		16.97	389	216	175	1,527	70
33	(SLC 133 X CT5) X 0198 S (323)	8,763	27.15		16.17	412	230	245	1,396	80
53	U & I Hybrid #7 X L-19	8,756	24.32		18.01	353	204	165	1,492	74
47	(SLC 129X Ov.1) EL 66P21	8,753	27.12		16.13	336	151	240	1,221	66
5	(SLC 133 X 030) X 29.002	8,648	26.56		16.27	308	145	182	1,166	68
43	7114 X 0461 S (246)	8,588	25.42		16.93	334	178	199	1,255	74
23	(SLC 133 X CT5) X 28.19	8,542	25.73		16.58	305	131	182	1,248	64
79	(L-53 X 9540) X SLC 133 X M'	8,525	26.89		15.85	458	175	287	1,799	74
61	7114 X 22.005	8,492	26.60		15.94	362	158	214	1,376	78
63	(L-53 X CT5) X 22.005	8,490	27.48		15.49	391	146	233	1,502	73
4	(L-53 X 712) X SLC 129 Rf	8,399	26.19		16.07	368	158	185	1,470	69
66	(L-53 X 9540) X 22.005	8,387	26.81		15.62	427	175	275	1,581	76

Table 6. continued

Code	Description	Acre Yield			Percent Sugar	Index	Amino		PPM			Beet Count
		Gross Sugar	Tons Beets				N		Na	K		
94	(SLC 133 X CT5) X L-19	8,375	23.88		17.57	389	201		251	1,557		71
40	(SLC 129 X Ov.2) X 0461s (246)	8,367	24.70		16.92	344	217		202	1,177		76
85	(L53 X NB-1) X SLC 133 X M'	8,358	26.92		15.53	485	190		342	1,762		64
68	(S33 X Ov.2) X 201 Rf	8,350	27.41		15.24	378	137		174	1,518		51
16	(NB-1 X L-53) X Am Cr 64-11	8,348	26.50		15.78	371	160		221	1,390		62
41	(S33 X NB-1) X 0461 s (246)	8,321	24.52		16.95	300	165		163	1,147		64
25	U & I Hybrid #7 X 28.19	8,309	24.81		16.76	339	180		201	1,269		70
60	(EL 31 X O30) X 0198 s (335)	8,277	24.63		16.84	350	161		156	1,499		63
92	(S33 X NB-1) X L-19	8,269	23.85		17.39	341	146		161	1,554		66
27	(SLC 133 X O30) X L-19	8,266	25.12		16.47	348	151		276	1,304		63
74	(SLC 129 X Ov.2) X 0461 s (282)	8,256	25.86		15.97	354	131		197	1,456		65
70	7114 X 0461 s (282)	8,250	25.32		16.29	335	163		198	1,246		75
35	(S33 X NB-1) X (US 35 X Ov)	8,236	25.65		16.08	355	166		181	1,355		76
89	(EL 31 X O30) X 27.53	8,230	25.40		16.21	344	169		177	1,306		48
21	7114 X Am Cr 64-11	8,183	26.27		15.61	376	131		240	1,484		58
73	(SLC 129 X L-53) X 0461s (282)	8,166	25.99		15.72	382	148		261	1,445		68
83	(L-53 X CT9A) X SLC133 X M'	8,164	25.83		15.82	454	220		250	1,639		75
82	(SLC129 X L-53) X SLC133 X M'	8,134	25.27		16.12	432	209		253	1,598		73
72	(SLC 129 X Ov.1) X 0461 s (282)	8,133	25.89		15.70	352	147		205	1,329		72
26	(EL 31 X O30) X 28.19	8,112	24.24		16.75	333	165		202	1,288		61
24	7114 X 28.19	8,074	24.47		16.48	336	164		196	1,285		68
86	(SLC 129 X Ov.2) X SLC133 X M'	8,045	25.04		16.07	387	154		226	1,548		74
76	(S33 X NB-1) X 0461s (282)	8,038	25.73		15.62	367	130		225	1,456		76
88	7114 X 27.53	8,024	25.17		15.97	341	132		292	1,235		66
44	(SLC129 X L-53) X EL 66P21	8,020	24.39		16.42	325	148		156	1,325		73
62	(L-53 X 712) X 22.005	8,003	26.17		15.32	463	192		288	1,655		64
54	U & I Hybrid #8	7,980	25.60		15.59	413	202		289	1,360		65
17	(SLC133 X O30) X Am Cr 64-11	7,964	24.37		16.35	323	137		244	1,219		60
42	(SLC133 X CT5B) X 0461s (246)	7,957	23.73		16.74	320	195		198	1,086		71
71	(FC601 X CT5) X 0461s (282)	7,952	25.42		15.67	377	167		243	1,348		74

Table 6. continued

Code	Description	Acre Yield		Percent Sugar	Index	Amino N		PPM		K	Beet Count
		Gross Sugar	Tons Beets								
37	(S33 X CT5) X (US 35 X 0v)	7,866	24.86	15.86	364	186	176	1,306	78		
8	(SLC133 X CT5) X 29.002	7,846	24.24	16.20	305	155	168	1,110	67		
90	(SLC133 X 030) X 27.53	7,828	24.86	15.77	338	146	236	1,261	65		
57	(SLC133 X CT5) X 0198S (335)	7,822	23.44	16.70	348	164	194	1,393	67		
49	7114 X EL 66P21	7,812	26.86	14.67	325	136	205	1,094	83		
22	(L-53 X 9A) X 28.19	7,799	24.37	15.98	333	147	195	1,274	67		
51	(SLC133 X CT5) X 29.005	7,746	23.73	16.27	339	175	185	1,246	70		
81	(SLC129 X 0v.1) X SLC133 X M'	7,745	24.19	15.99	403	172	242	1,546	65		
38	(SLC129 X 0v.1) X 0461S (246)	7,742	22.82	16.97	321	187	201	1,144	76		
65	(S33 X NB-1) X 22.005	7,715	25.04	15.37	428	173	235	1,606	70		
10	(SLC133 X 712) X 29.002	7,708	23.55	16.41	328	159	200	1,231	54		
91	(EL 31 X 030) X L-19	7,640	21.15	18.05	321	152	159	1,484	62		
13	(SLC129 X L-53) X Am Cr 64-11	7,573	23.80	15.92	371	150	239	1,430	43		
64	(NB-1 X L-53) 22.005	7,567	25.32	14.97	468	186	342	1,570	60		
12	(SLC129 X 0v.1) X Am Cr 64-11	7,550	23.16	16.31	301	128	201	1,174	46		
77	(SLC133 X FC 601) X 0461S (282)	7,542	23.88	15.77	364	137	260	1,385	72		
19	(SLC133 X CT5) X Am Cr 64-11	7,541	23.13	16.31	362	157	235	1,407	44		
67	(SLC133 X CT5) X 22.005	7,526	23.62	15.94	380	156	219	1,486	73		
50	(S33 X NB-1) X 29.005	7,526	23.62	15.93	370	164	154	1,483	56		
96	(NB-1 X EL31) X L-19	7,468	20.95	17.81	330	162	143	1,499	66		
2	(SLC133 X 712) X SLC 129 Rf	7,384	23.00	16.08	340	147	205	1,306	79		
15	(SLC129 X 0v.2) X Am Cr 64-11	7,351	22.90	16.07	320	123	183	1,311	44		
55	(SLC129 X L-53) X 22.005	7,349	20.15	18.23	307	181	137	1,322	57		
95	(SLC129 X 0v.1) X L-19	7,344	21.00	17.49	309	155	144	1,335	61		
6	(SLC133 X 9540) X 29.002	7,252	22.82	15.90	321	149	167	1,212	61		
39	(SLC129 X L-53) X 0461S (246)	7,246	21.59	16.81	346	213	189	1,195	67		
56	(S33 X NB-1) X 0198S (335)	7,239	21.64	16.74	334	146	154	1,435	52		
7	(S33 X NB-1) X 29.002	7,213	22.03	16.39	307	168	146	1,136	56		
52	7114 X 29.005	7,196	23.06	15.64	372	154	225	1,391	61		
28	(L-53 X CT5B) X L-19	7,177	21.25	16.88	291	125	136	1,278	56		



Table 6. continued

Code	Description	Acre Yield		Percent Sugar	Index	Amino		PPM		Beet Count
		Gross Sugar	Tons Beets			N		Na	K	
58	7114 X 0198 S (335)	7,113	20.74	17.12	312	146		124	1,378	55
29	(S33 X NB-1) X 28.19	6,717	20.41	16.43	304	127		159	1,268	59
18	(S33 X NB-1) X Am Cr 64-11	6,585	20.79	15.83	343	153		200	1,283	40
1	(FC 601 X CT5) X SLC 129 Rf	6,329	20.20	15.68	325	128		168	1,287	58
36	(SLC129 X FC 601) X (US35 X Ov)	6,019	18.22	16.52	377	172		298	1,389	43
14	(L-53 X 9A) X Am Cr 64-11	5,362	17.34	15.48	480	185		293	1,507	33
Mean of all varieties		8,074	24.89	16.25	360	165		215	1,374	
S.E. of Mean		412	1.27	0.24	22	17		41	5.15	
L.S.D. (5 percent point)		1,165	3.60	0.68	63	49		116	146	
C.V. Percent		12.50	12.53	3.60	15.05	25.85		46.56	9.18	
Calculated F		3.17**	3.69**	7.68**	3.97**	2.65**		1.90**	9.05**	

\*\* Significant at 1% level

Table 7 . Individual beet selections 0457 Logan, Utah, 1969 (6 reps)

Code	Description	Acre Yield			Percent Sugar	Index	Amino		PPM			Beet Count
		Gross Sugar	Tons Beets				N		Na	K		
4	(630aaXCT5+A-38aa HS-	5,777	22.75		12.69	404	168		88	1,254		74
3	(630aaXCT5+A) HS+	5,401	20.57		13.12	442	242		91	1,221		72
12	(630aaXCT5+A)-53aa HI-	4,989	19.42		12.82	461	244		127	1,202		74
7	(630aaXCT5+A)-25aa HS-	5,661	21.72		13.03	492	248		100	1,427		74
5	(630aaXCT5+A-48aa HS-	5,407	21.17		12.77	496	241		98	1,436		68
10	(630aaXCT5+A)-32aa HI-	5,985	22.95		13.02	503	255		118	1,426		76
9	(630aaXCT5+A)-1aa HS-	5,555	21.75		12.77	521	243		128	1,509		72
18	Parent 0457	5,661	22.55		12.53	528	249		107	1,490		72
1	(630aaXCT5+A)-12aa HS+	5,387	20.67		13.03	528	272		125	1,476		66
2	(630aaXCT5+A)-18aa HS+	5,714	22.17		12.92	544	301		91	1,471		76
6	(630aaXCT5+A) HS-	5,535	21.80		12.73	548	291		120	1,450		78
8	(630aaXCT5+A)-50aa HS-	5,405	21.22		12.72	560	303		122	1,463		76
17	(630aaXCT5+A)-10aa HI-	6,137	24.72		12.39	564	226		120	1,669		74
14	(630aaXCT5+A)-4aa HI-	4,897	19.12		12.73	565	321		135	1,395		80
11	(630aaXCT5+A)-29aa HI-	5,474	22.42		12.22	584	281		130	1,545		76
15	(630aaXCT5+A)-36aa HI-	5,603	22.62		12.39	604	295		136	1,612		76
13	(630aaXCT5+A)-45aa HI-	4,824	19.32		12.50	609	327		89	1,609		64
16	(630aaXCT5+A)-8aa HI-	5,357	21.97		12.18	647	290		126	1,807		68
Mean of all varieties												
S.E. of Mean		5,487	21.61		12.70	533	267		114	1,470		
L.S.D. (5 percent point)		186	0.70		0.18	31	20		9.4	75		
C.V. Percent		526	1.98		0.51	89	56		27	211		
Calculated F		8.31	7.92		3.48	14.43	18.32		20.24	12.43		
		3.34**	4.13**		2.42**	3.78**	3.70**		3.22**	4.15**		

\*\*Significant at 1% level

Table 8 . Individual beet selections 9229 Logan, Utah, 1969 (6 reps)

Code	Description	Acre Yield			Percent Sugar	Index	PPM			Beet Count
		Gross Sugar	Tons Beets				Amino N	Na	K	
7	9229-2aa HI-	5,798	23.20		12.50	468	204	155	1,319	76
4	9229-28aa HS-	4,940	20.15		12.28	494	237	125	1,288	65
12	Parent 9229	5,365	23.03		11.65	513	153	111	1,527	47
3	9229-3aa HS-	5,661	22.52		12.56	528	238	163	1,458	69
1	9229-7aa HS+	5,122	20.65		12.37	534	217	199	1,493	72
6	9229-12aa HS-	4,986	20.10		12.41	541	262	148	1,420	70
8	9229-6aa HI-	5,312	22.65		11.70	549	241	163	1,353	68
2	9229-39aa HS-	4,296	17.07		12.57	565	282	157	1,482	41
5	9229-45aa HS-	4,341	17.30		12.56	577	287	163	1,506	54
9	9229-34aa HI-	5,198	21.92		11.82	621	252	205	1,613	64
10	9229-10aa HI-	5,054	21.20		11.92	654	308	177	1,631	47
11	9229-13aa HI+	3,850	19.75		9.78	1,271	538	281	2,373	68
Mean of all varieties		4,960	20.59		12.04	618	279	176	1,540	
S.E. of Mean		230	83		0.20	40	24	14	81	
L.S.D. (5 percent point)		649	2.34		0.58	113	69	39	228	
C.V. Percent		11.33	9.83		4.14	15.82	21.40	19.32	12.83	
Calculated F		6.58**	6.04**		15.92**	3.11**	14.04**	8.83**	13.59**	

Table 9 . Individual beet selections 952 Logan, Utah, 1969 (6 reps)

Code	Description	Acre Yield		Percent Sugar	Index	Amino N	PPM		Beet Count
		Gross Sugar	Tons Beets				Na	K	
1	952-50aa HS+	5,589	22.80	12.25	489	229	132	1,295	74
4	952-34aa HS-	5,415	21.92	12.36	495	226	141	1,340	74
7	Parent 952	6,114	24.67	12.42	505	261	100	1,322	76
3	952-2aa HS-	5,638	22.72	12.40	559	271	99	1,549	75
2	952-10aa HS+	5,170	21.17	12.21	567	285	117	1,460	76
5	952-23aa HS-	5,145	22.12	11.62	567	267	119	1,387	78
6	952-29aa HI+	5,267	22.65	11.64	655	327	114	1,578	72
Mean of all varieties		5,477	22.58	12.13	548	267	117	1,419	
S.E. of Mean		203	0.81	0.17	39	27	8	83	
L.S.D. (5 percent point)		575	NS	0.49	NS	NS	23	NS	
C.V. Percent		9.09	8.75	3.46	17.60	24.76	17.09	14.39	
Calculated F		2.8**	NS	4.13**	NS	NS	3.47**	NS	



Table 10. Individual beet selections 0453, Logan, Utah, 1969 (6 reps)

Code	Description	Acre Yield		Percent Sugar	Index	Amino N		PPM			Beet Count
		Gross Sugar	Tons Beets			N		Na	K		
13	(CT5BaaX631+A)-6aa HS-	4,262	16.80	12.63	445	189		109	1,335		67
12	(CT5BaaX631+A)-43aa HS-	4,625	19.40	11.92	479	181		138	1,368		78
7	(CT5BaaX631+A)-50aa HS-	5,069	20.82	12.17	480	174		140	1,436		72
1	(CT5BaaX631+A)-22aa HS+	5,248	20.62	12.73	480	223		121	1,368		77
15	(CT5BaaX631+A)-4aa HI+	4,965	20.42	12.17	493	219		114	1,373		73
14	(CT5BaaX631+A)-19aa HI+	5,264	20.67	12.69	497	239		125	1,391		66
2	(CT5BaaX631+A)-34aa HS+	5,601	22.60	12.38	504	201		128	1,498		74
21	Parent 0453	4,990	20.05	12.42	508	201		125	1,544		61
5	(CT5BaaX631+A)-35aa HS-	5,253	21.37	12.27	520	234		143	1,414		78
8	(CT5BaaX631+A)-28aa HS-	4,783	19.20	12.47	521	218		126	1,533		66
20	(CT5BaaX631+A)-24aa HI++	4,713	19.47	12.07	523	209		124	1,511		64
9	(CT5BaaX631+A)-25aa HS-	4,867	20.47	11.84	527	195		136	1,521		77
11	(CT5BaaX631+A)-12aa HS-	4,523	19.30	11.72	535	206		153	1,445		76
10	(CT5BaaX631+A)-40aa HS-	4,591	19.15	11.99	548	271		126	1,376		60
18	(CT5BaaX631+A)-37aa HI+	4,958	21.15	11.72	558	219		168	1,493		74
19	(CT5BaaX631+A)-18aa HI+	5,092	21.67	11.77	575	217		146	1,578		73
6	(CT5BaaX631+A)-29aa HS-	5,933	23.60	12.56	577	268		128	1,635		76
4	(CT5BaaX631+A)-36aa HS-	5,010	20.12	12.45	577	276		121	1,581		65
17	(CT5BaaX631+A)-41aa HI+	4,706	20.75	11.35	580	199		161	1,599		69
3	(CT5BaaX631+A)-53aa HS+	5,355	21.57	12.39	678	361		130	1,690		75
16	(CT5BaaX631+A)-54aa HI+	4,715	20.40	11.57	695	334		160	1,601		66
Mean of all varieties											
S.E. of Mean		4,977	20.46	12.16	538	230		134	1,490		
L.S.D. (5 percent point)		223	0.78	0.21	36	25		11	71		
C.V. Percent		631	2.22	0.59	102	72		31	201		
Calculated F		10.98	9.40	4.17	16.34	27.06		19.70	11.70		
		2.96**	3.18**	3.60**	2.96**	3.55**		2.17**	2.06**		

\*\*Significant at 1% level

Table 11A. CMS versus pollinator yield trial, Logan, Utah, 1969 (8 entries, 7 reps)

Code	Description	Gross Sugar		Tons/acre		Percent Sucrose		Index
		Pollinator	CMS	Pollinator	CMS	Pollinator	CMS	
1	SLC 122	3,721	4,716	16.05	19.84	11.57	11.87	674 730
2	CT9	3,111	5,578	13.89	26.91	11.18	10.38	634 986
3	SLC 133	2,050	3,610	9.21	16.29	10.59	11.09	1,096 1,019
4	SLC 128	2,732	3,996	12.28	16.93	11.14	11.80	677 617
Mean all varieties		2,903	4,475	12.95	19.99	11.12	11.29	770 838
Sig. Diff 5%		567		243		0.44		113

Variance Table

Source of Variation	D.F.	Gross Sugar		Tons/acre		Sucrose		Index
		Mean Square	F	Mean Square	F	Mean Square	F	
Replications	6	26.53 X 10 <sup>4</sup>	--	3.68	--	0.7845	--	34.26 X 10 <sup>3</sup>
Treatments	1	34.58 X 10 <sup>5</sup>	12.53**	692.67	137.36**	0.3861	NS	64.19 X 10 <sup>4</sup>
Varieties	3	72.48 X 10 <sup>5</sup>	26.27**	156.21	30.93**	3.0255	18.60**	46.31 X 10 <sup>4</sup>
Treatment X Varieties	3	14.36 X 10 <sup>4</sup>	5.20**	60.97	12.07**	1.5079	9.27**	13.81 X 10 <sup>3</sup>
Error	42	27.59 X 10 <sup>4</sup>		5.05		0.1627		10.96 X 10 <sup>3</sup>
Total	55	13.42 X 10 <sup>5</sup>		28.70		0.4641		46.07 X 10 <sup>3</sup>

\* Significant at 5% level.

\*\* Significant at 1% level.

Table 11B. CMS versus pollinator yield trial, Logan, Utah, 1969 (8 entries, 7 reps)

Code	Description	Amino N		Na		K		Beet Count	
		Pollinator	CMS	Pollinator	CMS	Pollinator	CMS	Pollinator	CMS
1	SLC 122	276	370	94	116	1,866	1,814	54	60
2	CT9	284	424	89	122	1,572	2,200	36	60
3	SLC 133	590	538	173	135	2,024	2,165	34	50
4	SLC 128	331	321	125	112	1,517	1,469	50	62
Mean all varieties		370	413	120	121	1,745	1,912	44	58
Sig. Diff 5%		55		16		327		5.46	

Variance Table

Source of Variation	D.F.	Amino N		Na		K		Beet Count	
		Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F
Replications	6	12.06 X 10 <sup>3</sup>	--	505.58	--	93.41 X 10 <sup>4</sup>	--	16.95	--
Treatments	1	28.14 X 10 <sup>3</sup>	10.83**	11.16	NS	39.13 X 10 <sup>4</sup>	4.26*	721.45	28.15**
Varieties	3	18.69 X 10 <sup>3</sup>	7.19**	7,439.59	31.95**	87.12 X 10 <sup>4</sup>	9.48**	174.26	6.80**
Treatment X Varieties	3	27.61 X 10 <sup>3</sup>	10.63**	3,690.54	15.85**	35.96 X 10 <sup>3</sup>	3.91*	44.35	NS
Error	42	25.98 X 10 <sup>2</sup>		232.84		91.87 X 10 <sup>3</sup>		25.63	
Total	55	15.48 X 10 <sup>3</sup>		840.26		15.46 X 10 <sup>3</sup>		46.46	

\* Significant at 5% level

\*\* Significant at 1% level

## An Attempt to Produce Haploid Sugarbeet Plants from Pollen Grains

J. C. Theurer

In 1969 Nitsch and Nitsch (1) reported that they had developed haploid plants from pollen grains of tobacco. If haploid plants could be developed from pollen of sugarbeet, this would provide a new and extremely useful method for separation of minor genetic factors that influence male sterility. An experiment was conducted this year to study this possibility.

### MATERIALS AND METHODS

Flower buds of SLC 03 and one other inbred line of sugarbeets were excised from seedstalks, dipped in 70% alcohol and placed in 5% calcium hypochlorite solution for two minutes for surface sterilization. Anthers were removed aseptically from each flower bud and were placed on the special nutrient medium used by Nitsch and Nitsch (1). In some samples the anthers were left whole, while in others they were cut in two or macerated with a sharp scalpel. The Erlenmeyer flasks containing the medium were placed in a growth chamber at 75 F with approximately 3600 f.c. of cool white fluorescent light. When the experiment was terminated, weekly observations were made on the anthers for two months. In a second experiment flower buds were quickly dipped into 70% alcohol, rinsed with distilled water and then handled as listed above.

### RESULTS AND DISCUSSION

In both experiments there was no sign of mycelial growth or other evidence of contamination from fungi or bacteria.

There was no indication of plantlet development in any of the samples. Some of the whole anthers became slightly swollen, but no plantlets developed.

Several reasons could explain our negative results. First, it may be that this phenomenon is peculiar to tobacco plants. Microspores from alfalfa, safflower and crested wheatgrass placed in the same growth chamber and handled in a similar manner to that for sugarbeets also showed no development, other than swelling of anthers.

Nitsch and Nitsch (1) found that certain stages of microspore development were better than others, and that specific environmental conditions were needed for plantlet development. They also modified



their nutrient medium several times prior to obtaining good results with tobacco.

Different stages of pollen development, changes in nutrient medium, and changes in environmental conditions will be investigated before we positively conclude that haploid production from sugarbeet pollen is impossible.

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#### Linkage Studies with the $a_1$ Gene

J. C. Theurer

In 1967 we received several seedlots of possible mutants for use in linkage studies from the Great Western Sugar Co. Dr. R. K. Oldemeyer also supplied us with photothermally induced roots for some of these mutants. Crosses were made with these roots and 129 aa. The  $F_1$  plants all had normal fertile phenotype. In the  $F_2$ , segregation was noted for hypocotyl color (R), germ (M), and male sterility ( $a_1$ ), but in most cases the mutant phenotype was not observed in the  $F_2$  populations. The following table shows that two mutants, candy stripe, and peppermint-stick petiole (both pink striped petiole mutants) were independent of the  $a_1$  gene. In addition both mutants were expressed only in the presence of the red hypocotyl factor. It is our opinion that these two mutants are allelic with "R" and may be variations of the R allele.

Current No.	<u>Candy-stripe petiole</u>		<u>Non-candy-stripe petiole</u>	
	<u>F</u>	<u>MS</u>	<u>F</u>	<u>MS</u>
M8603	13	8	3	3
M8606	<u>Peppermint-stick petiole</u>		<u>Non-peppermint-stick petiole</u>	
M8606	49	19	22	11

Additional selection has been made in this Great Western material to obtain homozygous mutants for further study.

Crosses have been made of some of the mutants, which will be evaluated in 1970 and 1971.

Inheritance Studies of a Pollen Restorer from  
Ruby Queen Table Beet

J. C. Theurer

In Owen's (2) original extensive studies concerning the inheritance of cytoplasmic male sterility (CMS), he found that strong pollen-restorer genes were scarce in curly-top-resistant material. He noted that normal hermaphrodite beets crossed to CMS frequently segregated male-sterile, partial-fertile, and, at times, fertile offspring. However, there were no lines having 100% fertile progenies. He attributed this to the fact that these pollinator lines carried sterile rather than normal cytoplasm. Contrariwise, Bliss and Gabelman (1) reported that a single monogenic factor in the presence of sterile cytoplasm restored complete pollen fertility to sugarbeet X table beet material.

Theurer and Ryser (5) isolated an inbred from the sugarbeet variety US 201 that carried strong pollen fertility restorer factors (Rf). Genetic studies with this restorer indicated that two complementary genetic factors govern male sterility, which confirms Owen's (2) original premise. However, interaction of modifying genes and different cytoplasm and the influence of environmental factors were also evident. It was noted (3) that progenies of NB-1 CMS, 129 CMS, and CT9 CMS lines crossed with the US 201 Rf differed greatly in their fertility. This we have attributed mainly to the interaction of genetic modifying factors, rather than differences in cytoplasm. However, the cytoplasm could also have had an influence on the fertility of these populations.

Savitsky (3) suggested that different expressions of male sterility in sugarbeets were caused by different genes which influence the cytoplasm as well as different types of male-sterile cytoplasm.

The present study was instigated to determine the inheritance of pollen fertility restoration in crosses of the annual tester SLC 03 CMS and an Rf line derived from the Ruby Queen variety of table beet.

MATERIALS AND METHODS

In 1961 F. V. Owen crossed SLC 03 CMS with plants of the Ruby Queen variety of table beet. The  $F_1$  progeny (56 plants) from one hybrid were all classified as completely pollen fertile. We observed that segregation in subsequent generations gave varied ratios. The  $F_2$  offspring fit a 9:7 ratio with a probability of .90, suggesting that pollen restoration was governed by two complementary genetic factors. However, the  $BC_1$  yielded 59 fertile : 53 male sterile, which definitely would not support the two-gene model.

Selection of the most fertile plants for four selfed generations resulted in increased fertility in each generation and ultimately in a line that was 100% fertile, composed of plants each of which had over 90% stainable pollen (Figure 1). This selection, having pollen-restorer genes from Ruby Queen and sterile cytoplasm from SLC 03 CMS, was crossed to SLC 03 CMS to determine the inheritance of pollen-fertility restoration in uniform cytoplasm.  $F_1$ ,  $F_2$ , and  $BC_1$  populations were grown in a 70 F greenhouse. A sample of pollen or anthers was collected at anthesis from each plant. Classification for fertility was made by visual observation of anther color and pollen dehiscence and by microscopic observation of the percentage of aceto-carmin stained pollen.

### RESULTS AND DISCUSSION

The  $F_1$  progenies of the SLC 03 CMS X Rf crosses were all fertile, having good dehiscence and 50% or better stainable pollen. Seed production averaged .5 grams per plant. The  $F_2$  generation for eight families showed monogenic inheritance when plants were classified into pollen-producing plants versus white-anther male steriles (Table 1). However, there was wide variability in the degree of fertility. The  $BC_1$  populations segregated 1 male sterile : 1 fertile plant and gave excellent fit to the expected ratio with one exception (Table 2). Family RB 8108 had far more fertile segregates than expected. This was probably just a chance occurrence, however, since the  $F_2$  of this family (RB 8518) showed an excellent fit for monogenic inheritance. Fertility based on pollen dehiscence showed a similar inheritance pattern.

These results support those of Bliss and Gabelman (1) that table beet cultivars carry a strong pollen-restorer gene. However, our data are in conflict with theirs regarding complete pollen fertility restoration.

Wide variation in the percent of stainable pollen was observed regardless of the fact that both parents should have had the same cytoplasm, and that every plant of the  $S_4$  pollinator was 90% or more fertile (Figures 2 and 3). The influence of environmental factors is one possibility that might explain this plant to plant difference in degree of fertility. These would probably be micro-environmental factors that affect the physiology and development of pollen within the anther during microsporogenesis, rather than macro-environmental factors. In other research work we have not been able to demonstrate that this type of variation in the greenhouse was due to any specific environmental factors such as temperature, light, nutrition etc. Variation in fertility could be attributed to minor modifier genes of the two parents that are masked in the  $F_1$  but interact and express themselves in the  $F_2$ .

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Table 1.  $F_2$  segregation for pollen fertility restoration.

	Fertile	Male Sterile	Expected (3:1) Ratio	$\chi^2$	P
RB8502	105	31	102:34	.353	.50-.70
RB8503	504	169	505:168	.008	.90-.95
RB8505	230	90	240:80	1.77	.20-.30
RB8508	548	168	537:179	.90	.30-.50
RB8514	159	35	145.5:48.5	5.01	.02-.05
RB8515	486	194	510:170	4.52	.02-.05
RB8517	110	40	112.5:37.5	.22	.50-.70
RB8518	161	47	156:52	.64	.30-.50
Total	2303	774	2308:761	.044	.80-.90

Table 2.  $BC_1$  segregation for pollen fertility restoration.

	Observed		Expected		$\chi^2$	P
	Fertile	Male Sterile	Fertile	Male Sterile		
RB8101	9	15	12	12	1.50	.20-.30
RB8102	125	112	118.5	118.5	.71	.30-.50
RB8103	12	12	12	12	--	1.00
RB8104	344	337	340.5	340.5	.072	.70-.80
RB8105	20	14	17	17	1.06	.30-.50
RB8106	17	17	17	17	--	1.00
RB8107	153	154	153.5	153.5	.006	.90-.95
RB8108	87	58		72.5	5.80	.01-.02
Total	767	719		743	1.55	.20-.30

Population No.	11120	251111	RB35111	RB35349	RB4575
Generation	<u>F<sub>1</sub></u>	<u>S<sub>1</sub></u>	<u>S<sub>2</sub></u>	<u>S<sub>3</sub></u>	<u>S<sub>4</sub></u>
Number plants	<u>F MS</u> 56:0 → <u>F MS</u> 43:34 → <u>F MS</u> 57:6 →	<u>F MS</u> 54:0 79:1 36:0 73:0 54:1 47:1 88:0 63:1 120:0 79:5	<u>F MS</u> 66:2 33:0 18:1 15:0 25:2	<u>F MS</u> 41:0 30:0 35:0 24:0 34:0 26:0 32:0 26:0 35:0	<u>F MS</u> 41:0 30:0 35:0 24:0 34:0 26:0 32:0 26:0 35:0

Figure 1. Fertility of selfed restorer lines from the cross SLC 03 CMS X 0333 (Ruby Queen table beet)

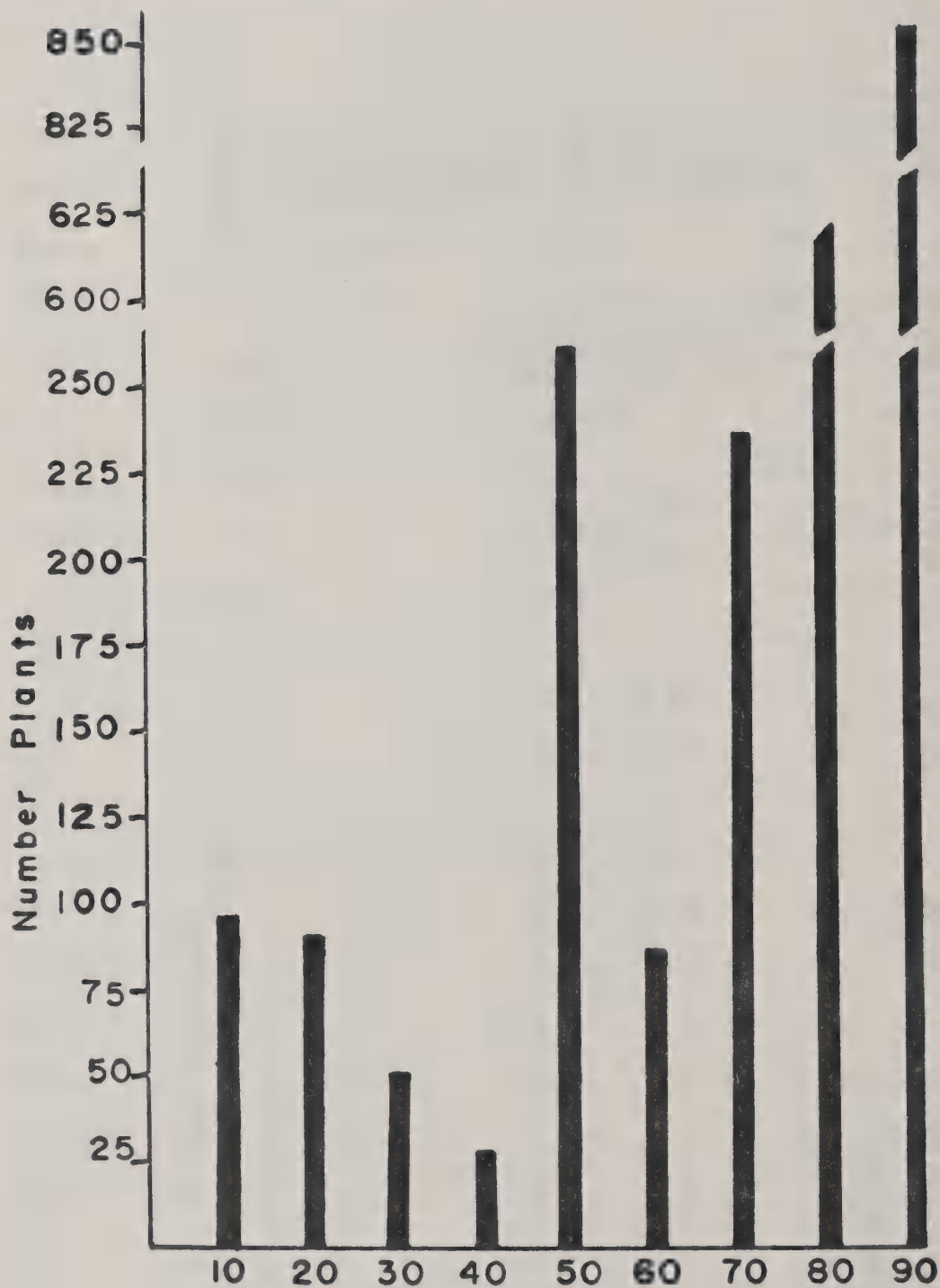


Fig. 2 --F<sub>2</sub> Fertility Percent for SLC 03 X  
Ruby Queen Pollen Fertility Restorer.

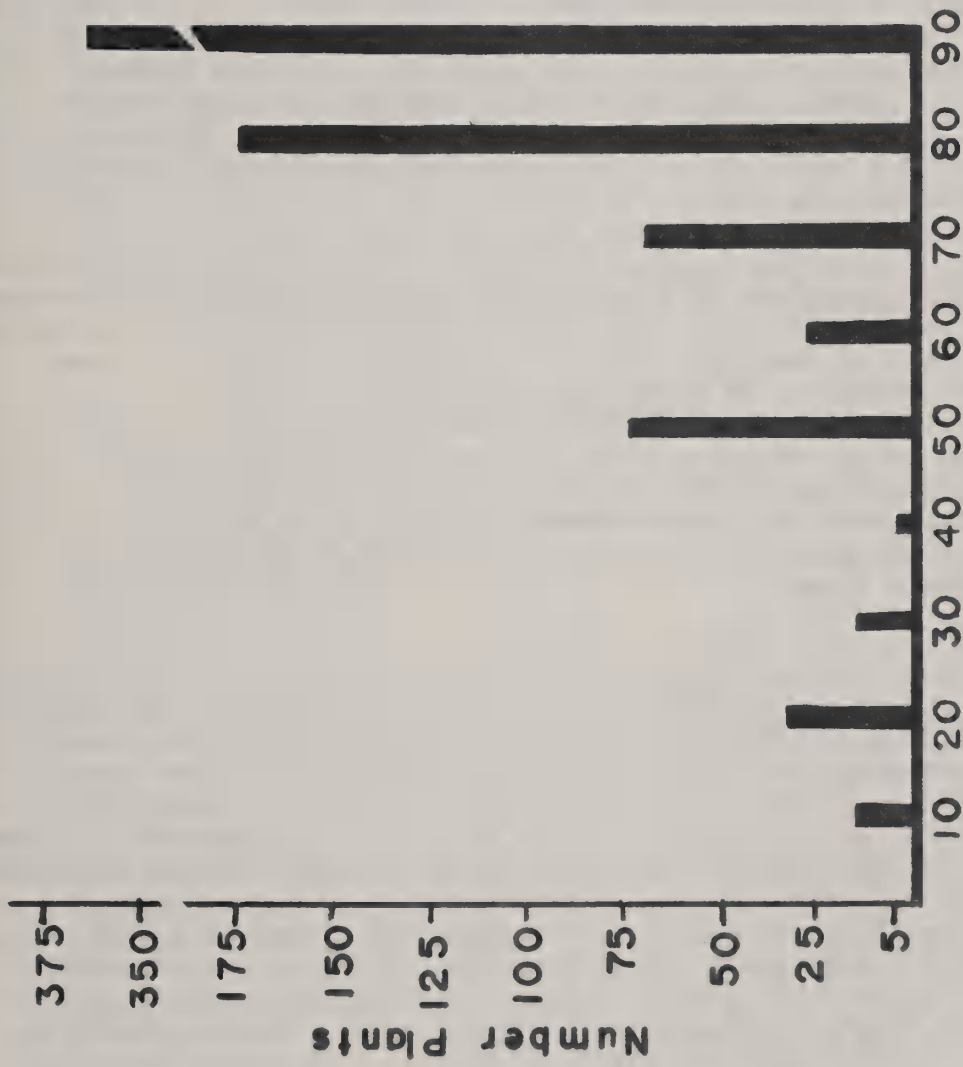


Fig. 3--BC<sub>1</sub> Fertility Percent for SLC 03 X  
Ruby Queen Pollen Fertility Restorer.



## Environmental Studies of Partial Male Fertility

J. C. Theurer and E. H. Ottley

In early studies of cytoplasmic male sterility (CMS) Owen (4) recognized that environmental variability made classification difficult. He found that sudden cool temperatures in the spring of the year resulted in "blasting" of anthers, making it almost impossible to discern which plants were indeed male steriles. We experienced this effect in seed isolation plots in 1963, but were unable to duplicate the field results in growth chambers (see 1964 report). Plants grown at 55, 65, and 75 F showed no difference in fertility. An attempt to alter the carbon-nitrogen ratio by weekly application of 2% urea or 3.5% sugar had no effect on fertility. Cleij (1) reported that exposure of CMS annual beet material to a temperature of 55 F resulted in male-fertile plants. Nutrition, photoperiod, and day length have also been cited by various scientists as environmental factors influencing CMS (2, 3, and 7).

In a 1963 study (see 1963 report) we found no consistent differences in fertility when various male-sterile and partial-fertile lines were subjected to high or low light intensity, when the inflorescence was bagged or left unbagged, or whether or not plants were given foliar applications of minor elements. Plants grown at 45 F showed blasting in many of the partial-fertile lines, but no temperature difference was noted for plants grown in a 65 F environment versus 55 F. Our observations concur with those of Nielson and Nemazi, (3) that partial male-fertile lines are more subject to environmental influences than are CMS or Type O lines.

### MATERIALS AND METHODS

In the 1966 field reading plots at Logan, an F<sub>1</sub> hybrid, 51115, was classified as 100% partial fertile. All plants of this variety had dark yellow anthers with little if any pollen dehiscence. Two plants from this variety were vegetatively propagated, using Owen's (5) seed-stalk technique, for use in studying the effects of environmental factors on CMS. Rooted cuttings were transplanted to a 50:50 sand-peat mixture in 6-inch pots and were kept in the greenhouse at 70 F until they had produced a rosette of new leaves. Then they were placed in a cold chamber at 45 F for 12 weeks for photothermal induction. Forty-eight plants of 51115-1 and 48 of 51115-2 were divided into four equal groups based upon the vegetative development of each plant. Twelve plants of 51115-1 and an equal number of plants of 51115-2 were placed in each of the four growth chambers used in the study.

All growth chambers were maintained at 60 F for 10 days and at 70 F thereafter. Light intensity and day length for each chamber was

as shown below.

<u>Chamber No.</u>	<u>Light Intensity</u>	<u>Day length</u>
1	3600 f.c. (approx)	16 hr.
2	3600 f.c.	24 hr.
3	1800 f.c.	16 hr.
4	3600 f.c.	8 hr.

Four plants of each variety in each chamber were watered daily with distilled water. Another set of four plants was given only minimal water, keeping the plants under a moisture stress and temporary wilt situation. The third set of four plants in each chamber was given 1/2 N Hoagland solution daily.

Pollen or anthers from each plant were stained with aceto-carmin and microscopically analyzed for fertility when the first flowers opened and also one week later. Each plant was bagged before flowers opened and seed was harvested from each plant.

#### RESULTS AND DISCUSSION

Plants of these two clonal populations showed considerably more fertility in the growth chambers than they previously exhibited in the field. Most plants had yellow anthers that dehisced well, with a high percentage of stainable pollen (Table 1).

Analysis of variance showed no significant effects of light intensity of 16- or 24-hour day length, of water and nutrient differences, or interactions of these factors, on pollen fertility. In the 8-hour day length environment, nine of the 12 plants of 51115-2 remained vegetative. The three plants that did bolt showed less than 10% fertility. Population 51115-1 had fertility equally as good as in the other environments for this 8-hour day length environment. This could indicate that although these two clonal populations were derived from the same  $F_1$  cross, they carry different genetic factors that are subject to environmental influences. Perhaps day length has a bearing on fertility of 51115-2, but one would not be justified in drawing such a conclusion based on three plants. Population 51115-2 was slightly lower in stainable pollen than was 51115-1 in all environments.

Owen (6) expressed the opinion that environmental variability may be a physiological disturbance which might be regarded as a period of shock, rather than being due to such factors as temperature, moisture stress, photoperiod etc. A comparison of field data and the above growth chamber data would lend support to this premise.

The average seed production for the plants in the four environments is given in Table 2. The greatest quantity of seed per plant was noted in environment #2 wherein plants were subjected to continuous illumination at the higher light intensity. In general, plants given adequate water produced more seed than plants under moisture stress or those having high nutrition. Plants grown under 16-hour day length and at the lower light intensity (environment #3) showed a detrimental effect for seed production when they were given Hoagland solution daily, since only one of eight plants given this treatment produced seed. All of the plants, except the three that produced seed in environment #4, were either completely vegetative or produced vegetative seedstalks devoid of flowers.

A second experiment consisting of clonal lines of male-sterile, partial-fertile, fertile- O type, and pollen-restorer beets was set up in the growth chambers this year. This experiment was terminated early, however, because over 80% of the cloned plants failed to bolt, even though they had had in excess of 5 months photothermal induction in our cold room. This experiment will be repeated when clonal material is again available for such a study.

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Table 1. Mean fertility of 51115-1 and 51115-2 populations in growth chamber environments.

Environments	Fertility %	
	51115-1	51115-2
<u>Environment #1 - 16-hour day - 3600 f.c.</u>		
Moisture stress	90	75
Water	90	88
Hoagland solution	90	70
<u>Environment #2 - 24-hour day - 3600 f.c.</u>		
Moisture stress	90	85
Water	78	70
Hoagland solution	90	83
<u>Environment #3 - 16-hour day - 1800 f.c.</u>		
Moisture stress	90	80
Water	88	88
Hoagland solution	80	85
<u>Environment #4 - 8-hour day - 3600 f.c.</u>		
Moisture stress	90	5*
Water	88	10*
Hoagland solution	80*	-*

\*Three plants of 51115-1 treated with Hoagland remained vegetative under 8-hour days. Two, three, and four plants were vegetative for 51115-2 clones for moisture stress, water, and Hoagland treatments respectively.



Table 2. Seed production of 51115-1 and 51115-2 populations in growth chamber environments.

Environments	No. plants producing seed		Avg. seed wt. (gms)	
	51115-1	51115-2	51115-1	51115-2
<u>#1 16-hour day - 3600 f.c.</u>				
Moisture stress	4	3	1.26	1.42
Water	4	3	1.56	1.73
Hoagland solution	3	4	1.48	1.04
<u>#2 24-hour day - 3600 f.c.</u>				
Moisture stress	4	4	3.64	2.58
Water	4	4	4.09	2.83
Hoagland solution	4	3	3.25	6.50
<u>#3 16-hour day - 1800 f.c.</u>				
Moisture stress	3	3	.92	.62
Water	3	3	.80	.87
Hoagland solution	1	0	.60	--
<u>#4 8-hour day - 3600 f.c.</u>				
Moisture stress	2	0	.55	--
Water	1	0	.30	--
Hoagland solution	0	0	--	--

## The Use of a Sand-Peat Medium for Growing Sugarbeets in the Greenhouse

David L. Mumford

Several difficulties have been encountered in recent years in obtaining satisfactory soil for greenhouse use. It has been impossible to obtain during winter months or other periods of wet weather. Great variation has occurred between batches, particularly with regard to fertility and texture. The possibility of getting soil that was contaminated with materials toxic to plant growth has been increasing.

In an effort to avoid some of these difficulties, we have been experimenting with the use of a mixture of equal parts of washed sand and sphagnum peat moss. These materials are readily available at any time. They are consistently the same from batch to batch and are free of toxic contaminants. In our preliminary tests, where the mixture has only been used once and discarded, it has not been necessary to sterilize it. Thorough mixing of the two materials has been accomplished using a cement mixer.

Our conclusions to date indicate that the best procedure for fertilization of sugarbeets in the sand-peat medium is to use a nutrient solution until the second pair of true leaves are out, then a dry commercial fertilizer can be used. Our nutrient solution consists of 500 ml each of three 20 Normal Hoagland stock solutions in 5 gallons of water with minor elements added. The dry granular fertilizer being used consists of 6% available nitrogen, 10% phosphorus, 4% potassium, and 1% iron.

Most of our seedlings are transplanted in the cotyledon stage into 5 or 6-inch pots. No fertilizer is applied for two days after transplanting. After the second day, seedlings are watered three times a week with nutrient solution diluted with an equal amount of water (1/2 strength). This is continued until the first true leaves are approximately 1/4 inch expanded. The plants are then watered with regular nutrient until the second pair of true leaves are fully expanded. At any time after the plants reach this stage, they can be fertilized with 1/4 teaspoon of the dry granular fertilizer every ten days. Using this procedure plants have been grown in the same pot for as long as 18 months.

Our experience has shown that extreme caution must be used to avoid toxicity from excess fertilizer on young seedlings in the sand-peat medium. This may vary somewhat with changes in season, but until the first true leaves emerge, seedlings are very susceptible to burning from either dry granular fertilizer or nutrient solution with the concentration too high.

Tests will be made to determine whether the sand-peat medium can be successfully reused. It seems probable that it could be effectively sterilized either with steam or methyl bromide fumigant and used several times.

## Virulence of Curly-Top Isolates from the Pacific Northwest

David L. Mumford

Isolates of curly-top virus were collected from the sugarbeet areas of Washington and Oregon in 1968 and from western Idaho in 1969. These isolates were transferred in the greenhouse to a susceptible inbred variety of sugarbeet to provide uniformity of virus source material. The virulence of each isolate was evaluated by inoculating both a resistant and a susceptible sugarbeet variety and determining disease reaction.

In 1969 two additional isolates were included for comparative purposes. One isolate was strain 11, described in 1954 by N. J. Giddings as a severe strain obtained from Idaho. The other isolate (66-10) was collected by D. L. Mumford in 1966 in a curly-top disease evaluation nursery located west of Thatcher, Utah. Isolate 66-10 has been compared with the most virulent strains of curly top described to date, including the Los Banos strain from California described by C. W. Bennett. It has been found to be more virulent than any known strain. In 1968 only isolate 66-10 was included for comparative purposes.

Table 1 presents the average reaction of each isolate on twenty plants of each sugarbeet variety. Although none of the isolates from Washington and Oregon tested in 1968 were as virulent as 66-10, at least three isolates approached that level of virulence and were obviously more virulent than strain 11. Four of the isolates from western Idaho tested in 1969 were equal to or greater in virulence than strain 11.

During the last three of four years severe local epidemics of curly top have been occurring with increasing frequency in the Northwest. This has been true despite the general use of increasingly more resistant varieties of sugarbeet. Information presented here on virulence of curly-top isolates supports the theory that there is an increasing prevalence of increasingly more virulent strains of curly-top virus. It seems probable that this trend could be at least partly responsible for the increase in occurrence of epidemics. It also seems probable that use of more resistant varieties will tend to gradually select and favor increased prevalence of more virulent virus strains.

Factors other than virulence of curly-top strains also play an important role and must not be forgotten. The balance between severe curly-top development on one side and successful sugarbeet growth on the other is greatly influenced by the efforts of individual growers. In addition to using resistant varieties, growers must use cultural practices that establish sugarbeet stands early and avoid unnecessary stress on plant growth. When practical, insecticides should be used to reduce hopper populations both in breeding areas and in the sugarbeet fields.

Table 1. Virulence of curly-top isolates from the Pacific Northwest

Location	Identification No.	3561 <sup>b/</sup>	Grade <sup>a/</sup> NB-1 <sup>c/</sup>
<u>1968 Tests</u>			
Walla Walla, Washington	68-3	7.7	2.6
" " "	68-4	6.9	1.0
Toppenish, Washington	68-6	7.3	1.5
Quincy, Washington	68-7	6.6	0.0
Othello, Washington	68-10	8.1	2.6
Pasco, Washington	68-13	6.9	1.8
Nyssa, Oregon	68-14	7.3	2.6
Utah	66-10	8.4	3.0
<u>1969 Tests</u>			
Mt. Home, Idaho	69-1	5.3	1.8
Grand View, Idaho	69-2	6.8	1.7
Nampa, Idaho	69-3	6.4	2.0
Dry Lake, Idaho	69-4	5.4	1.0
Grand View, Idaho	69-5	6.6	2.0
Buhl, Idaho	69-6	6.3	1.7
Idaho	Strain 11	5.9	1.7
Utah	66-10	7.9	3.3

<sup>a/</sup>Grades based on scale of 0-9 with 0 = no symptoms and 9 = dead

<sup>b/</sup>Susceptible variety

<sup>c/</sup>Resistant variety





## SUGARBEET RESEARCH

1969 Report

### Section D

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Holly Sugar Corporation  
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## SUMMARY OF ACCOMPLISHMENTS, 1969

1. New Facilities and Staff for Sugarbeet Research at Fort Collins, Colorado, December 31, 1969 (J.O. Gaskill). Occupancy of the new A.R.S. Crops Research Laboratory on the Colorado State University Campus was begun on January 6, 1969, and the formal dedication ceremony was held on August 19. The Sugar Laboratory, on the C.S.U. Agronomy Research Center, was put fully into operation in the fall of 1969. These two units, costing \$1,000,000 in Federal funds, were erected on land donated to the Federal Government by Colorado State University. Approximately 70 percent of this entire research complex is assigned to sugarbeet-oriented research programs conducted by two branches of the Crops Research Division of A.R.S.

A 26-acre tract of privately owned land, known as the "Warren Tract", was leased by the Beet Sugar Development Foundation at the beginning of 1969 to replace the Hospital Farm for pathologic plot work. A Shop and Machinery Storage Building (2,800 sq. ft.), constructed with Federal funds adjacent to the Sugar Laboratory, was put fully into operation in 1969 as a replacement for some of the buildings on the Hospital Farm.

Two research scientists and one technician were added to the Sugarbeet Investigations staff at Fort Collins, during the second quarter of 1969, by transfer from other stations maintained by the Tobacco and Sugar Crops Research Branch. Research scientists now on the Fort Collins staff include two plant pathologists, two geneticists, and one chemist.

2. Rhizoctonia Resistance Breeding Investigations, 1969 (J.O. Gaskill and E.G. Ruppel). In a replicated field experiment, all six "FC" strains--products of Rhizoctonia resistance breeding--were quite significantly superior to the following check varieties in resistance to Rhizoctonia: US H20, GW 674-56C, US H9B, and SP 5822-0. The resistance of FC 701/2 was significantly higher than that of its immediate parent, FC 701.

On the basis of 2 years' results, obtained in experiments conducted at Fort Collins, Colorado, and Logan, Utah, the following tentative conclusions were drawn: (a) Resistance to leaf spot, curly top, and Rhizoctonia root and crown rot is inherited independently; and (b) combining genetic resistance to these three diseases, in the same sugarbeet strain, is feasible (article by J.O. Gaskill, D.L. Mumford, and E.G. Ruppel, currently in the review process).

3. Growth and Cultural Characteristics of Several Rhizoctonia Isolates from Sugarbeet (E.G. Ruppel). Significant differences in growth and different cultural characteristics among isolates of Rhizoctonia solani from diseased sugarbeet specimens indicated that divergent populations (races?) of the fungus exist in Colorado and Arizona. Root-rot, crown-rot, and foliar isolates were easily distinguished by their growth habits.

4. Inheritance of Resistance to Cercospora Leaf Spot in Sugarbeet (Garry A. Smith and John O. Gaskill). Estimates of the heritability of resistance to Cercospora leaf spot in sugarbeet and the number of genes controlling resistance were made by means of one leaf spot resistant and two susceptible lines and their  $F_1$  and  $F_2$  hybrids. Individual-plant leaf spot ratings were made on a total of 2880 plants in a randomized block experiment with 40 replications in each of 2 years.

Results indicated that a minimum of 4 or 5 pairs of genes control resistance to leaf spot and that more genes may be active under severe epidemic conditions than under less severe conditions. Broad sense heritability estimates indicated that 60 to 71 percent of the variation in the  $F_2$  populations was genetic in nature. Frequency distribution of the  $F_1$  and  $F_2$  populations and the means of the  $F_1$  and parental populations suggested that part of this genetic variation was due to non-additive gene action.

5. Development and Evaluation of Sugarbeet Breeding Material and Varieties with Resistance to Both Leaf Spot and Curly Top, 1969 (J.O. Gaskill and E.G. Ruppel). The principal objectives of this project in 1969, as in the recent past, were the development of the following types of breeding material with high resistance to both leaf spot and curly top, high combining ability for beet yield, high sucrose percentage, and other desirable characters: (a) monogerm, type-0 lines and their CMS equivalents; and (b) male-fertile lines suitable for use as pollinators in the production of hybrids. Results obtained at Fort Collins, Colorado, and Logan, Utah (tests at Logan conducted by D.L. Mumford), indicated progress, but details are not presented in this report.

Evaluation of experimental hybrids (so-called "LSR-CTR varieties") by cooperators at numerous locations constituted an important part of the total effort on this project. Relative 1969 performance of certain varieties, included in this cooperative evaluation program in previous years, was out of line with the earlier results. For this reason, and in view of the fact that weather conditions in 1969 were quite far from normal, generalizations on the basis of the 1969 results should be made with caution.

6. Longevity of Cercospora beticola Inoculum under Refrigeration (E.G. Ruppel). Spores of Cercospora beticola remained pathogenic and 100% viable in aqueous suspension under refrigeration for 14 days. Viability remained near 100% up to 28 days, but declined rapidly between 28 and 34 days. Bacterial contamination after 14 days may have been influential in shortening the longevity of the spores.

7. Growth Habits of Single-spore Isolates of Cercospora beticola on Five Agar Media (E.G. Ruppel). Differences in growth among 14 single-spore isolates of Cercospora beticola on potato-dextrose or Czapek's solution agars were not significant. Significant differences in growth



occurred on corn meal, V-8 juice, and sugarbeet leaf extract agars. However, a significant isolates x media interaction indicated that the relative behavior of the isolates differed on the test media. Differences in cultural characteristics also were evident, but, again, the relative behavior of the isolates depended on the media. Thus, no grouping of isolates was possible based on growth or mutual characteristics on all media.

8. Disease Observations in Colorado, Texas, New Mexico, and Utah (E.G. Ruppel and J.O. Gaskill). In a brief survey of sugarbeet fields near Rocky Ford, Colorado, Hereford, Texas, Clovis, New Mexico, and Logan, Utah, in September, 1969, most striking was the rather high incidence of beet mosaic and Cercospora leaf spot in the Hereford and Clovis areas and the ubiquitous occurrence of virus yellows in all fields visited.

9. Amino Acid Study of Sugarbeet Samples from Healthy and Cercospora Infected Plants (G.W. Maag, R.J. Hecker, and J.O. Gaskill). Four populations of sugarbeet with a wide range of resistance to Cercospora leaf spot were selected for a study primarily of amino acids of healthy and Cercospora infected leaves. The leaves were also analyzed for the phenolic compound, 3-hydroxytyramine, which is believed to be related to Cercospora resistance. Root yield and thin juice characters of the healthy and diseased plants were determined. Six leaf samplings were taken from July 5 to September 3, 1968 from the diseased and healthy plants. The plants at the disease nursery were inoculated with Cercospora beticola on July 8 just after the first leaf sampling. As the disease progressed the fresh leaves were analyzed for the amino acids and 3-hydroxytyramine. Twenty-one amino acids were found in sugarbeet samples. Glutamic acid was the most predominant amino acid with usually more in the healthy samples than in the diseased samples. GABA was more predominant in diseased plants and Dopa was found in roots and diseased leaf samples. There were also population differences in some other amino acids. The relationship between certain amino acids and infection remain to be established as well as the possibility of utilizing certain amino acid determinations in disease resistance evaluation.

10. Effect of Nitrogen Fertilization on Amino Acid Content of Sugarbeet (G.W. Maag and R.J. Hecker). Fresh leaf, root, and thin juice samples were analyzed for free amino acids on three sugarbeet populations, one an open pollinated multigerm variety and two F<sub>1</sub> hybrids. Five nitrogen fertility levels were used, 0, 125, 250, 375, and 500 lbs. nitrogen per acre. Root yield and thin juice character components were also studied. Eighteen amino acids were quantitatively measured in sugarbeet thin juice, nineteen in fresh root, and twenty in leaves. Three unidentified amino acids were also present in measurable quantity. Dopa (dihydroxyphenylalanine) was in root but not thin juice samples. It was found in leaves only when disease lesions were present. Leaves also contain cystine which was not found in thin juice and roots. The most predominant amino acid in thin juice and leaves is glutamic acid. Root tissue contains large quantities of both glutamic and a

combination of serine, glutamine and asparagine which could not be measured separately under the conditions used for amino acid analyses. Increased nitrogen did not uniformly cause increase in amino acids, yield, and thin juice characters. Population differences were also noted. Correlation studies have not been made because leaf analyses are not yet complete.

11. Heterosis in Sugarbeet as Affected by Nitrogen (R.J. Hecker and G.W. Maag). A field study of an array of  $F_1$  hybrids and their parents revealed that there was heterosis, measured as deviation from midparent, for lower quantities of thin juice total nitrogen, betaine, amino nitrogen, potassium, calcium, magnesium, and chloride; nitrate and sodium showed heterosis for higher quantity. Potassium was the only impurity which exhibited best-parent heterosis. The magnitude of heterosis for yield characters (root yield, sucrose, purity, and recoverable sugar) and thin juice impurities (except nitrate) was not affected by nitrogen fertility level. In making hybrid comparisons for these characters it would be best to evaluate for low nitrate at low nitrogen fertility while other characters should probably be compared at optimum to high nitrogen fertility.

12. Predicting Performance of Double Cross Hybrids in Sugarbeet (Garry A. Smith and Richard J. Hecker). Five methods of predicting performance of double cross hybrids in sugarbeet were evaluated. Data were obtained on 35 double cross hybrids, 15 single cross hybrids, and 6 red beet top cross hybrids representing 6 inbred lines. Correlation coefficients of actual and predicted double cross performance for the five prediction methods appeared to have little if any relation to the percentage of the actual top 15 double crosses predicted.

When the top 15 double crosses were compared to the predicted top 15 for each prediction method, the mean of the four nonparental single crosses was the most consistent predictor for the four characters measured.

13. A Search for Apomixis in Sugarbeet (Garry A. Smith and Richard J. Hecker). An apomixis screening program initiated in April 1969 yielded 3 lines which represent possible apomicts. These three lines (2 from the same inbred) were retained for further tests after 201 plants representing 10 varieties and inbreds were screened. The screening of approximately 3000-4000 mother beets representing 20 different varieties or inbreds began in December 1969.

14. Studies on Inducing Male Sterility in Sugarbeet (R.J. Hecker and G.A. Smith). A study to compare male sterility induction by oestrone (a female sex hormone) and FW-450 showed that oestrone, unlike FW-450, had no phytotoxic effects and did not reduce seed yield or germination. However, oestrone was not as effective as a male gametocide; it induced 20 to 80% pollen sterility dependent on genotype and treatment method. Considerable nondisjunction was observed in meiotic pollen mother cells. Experience has shown FW-450 to have little commercial promise as a male gametocide; we feel oestrone shows sufficient promise to warrant further experimentation.



NEW FACILITIES AND STAFF FOR SUGARBEET RESEARCH  
AT FORT COLLINS, COLORADO, DECEMBER 31, 1969

John O. Gaskill

Occupancy of the new A.R.S. Crops Research Laboratory on the Colorado State University Campus was begun on January 6, 1969, and the formal dedication ceremony was held on August 19, 1969 (Figures 1 and 2). The Sugar Laboratory on the C.S.U. Agronomy Research Center (Figure 3) was put fully into operation at the beginning of harvest in the fall of 1969. These two units, costing \$1,000,000 in Federal Funds, were erected on land donated to the Federal Government by Colorado State University.

Completion of the two units described above represents a major milestone in the development of sugarbeet research facilities in the United States, as evidenced by the following. The Crops Research Laboratory, including the main building, headhouse, and greenhouses, amounts to a total of about 22,000 square feet of space (gross). Of the total assignable space, approximately 62 percent is devoted to sugarbeet-oriented research, including weed control studies performed by the Crops Protection Research Branch of the Crops Research Division of A.R.S. (13 percent) and projects conducted by the Sugarbeet Investigations unit of the Tobacco and Sugar Crops Research Branch (49 percent). The Sugar Laboratory (5,600 square feet, gross), including beet and seed storage areas, a sugar-purity laboratory, and related space, is assigned entirely to the Sugarbeet Investigations unit. Thus, approximately 70 percent of the million-dollar research complex is assigned to sugarbeet-oriented research programs.

Because of other uses for the land, it was necessary for us to vacate the Hospital Farm entirely at the end of 1968. This farm had served a variety of sugarbeet research programs very well for about 50 years. Beet and seed storage and seed preparation space on the Hospital Farm were replaced by better facilities in the new Sugar Laboratory on the Agronomy Research Center. Another structure, called the "Shop and Machinery Storage Building", was erected in 1968, adjacent to the Sugar Laboratory, by means of Sugarbeet Investigations funds. This building, shown in Figure 4 and covering 2,800 square feet, was put into full operation in 1969. In addition to shop and machinery storage purposes, it provides space for drying, threshing, and cleaning seed, and for storage of supplies, Cercospora inoculum, and miscellaneous items.

Arrangements were completed early in 1969 for a 26-acre tract of land, near the Sugar Laboratory, to replace the Hospital Farm for pathologic plot work. This land, called the "Warren Tract", is privately owned. It was leased from the owners by the Beet Sugar Development Foundation. After 1 year's experience on this tract, we are well

pleased with it. Unfortunately, however, the lease will expire at the end of 1973, and it seems unlikely that the owners will be willing to extend it. Consequently, steps should be taken soon in an attempt to complete arrangements for suitable, permanent, replacement land long before the expiration of the current lease.

The opening of the Crops Research and Sugar Laboratory buildings permitted consolidation and expansion of the Sugarbeet Investigations staff at Fort Collins in 1969. Staff members housed in quonsets at 630 West Lake Street, in the C.S.U. Biophysical Sciences Building, and at the Hospital Farm moved to the new quarters in January. Two research scientists and one technician were transferred to the staff, by the end of June, from other stations maintained by the Tobacco and Sugar Crops Research Branch. The research scientists currently on the staff include two plant pathologists, two geneticists, and one chemist. All five of the positions are considered as permanent; none are trainee type.

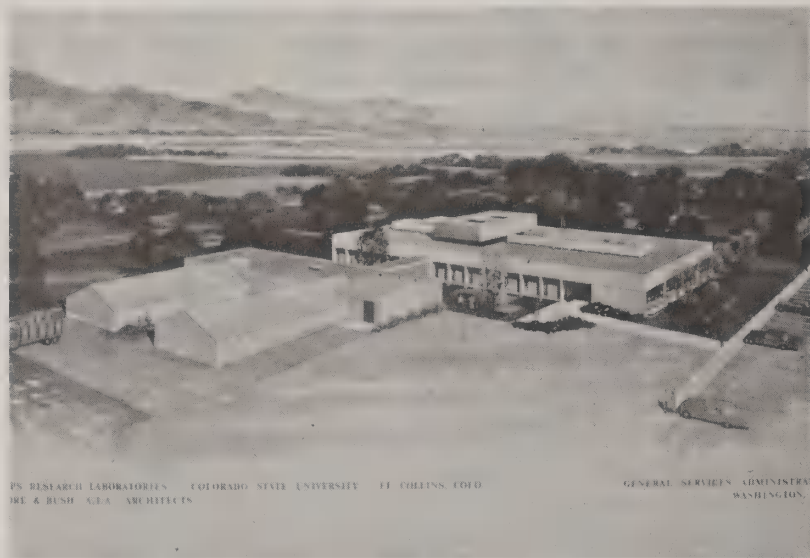


Fig. 1. General view of Crops Research Laboratory, on the C.S.U. Campus. (Artist's conception).



Fig. 2. Dedication ceremony for Crops Research Laboratory, 8/19/69. (Photo. by E. G. Ruppel).



Fig. 3. Sugar Laboratory, on the C.S.U. Agronomy Research Center. (Photo by C.S.U.)



Fig. 4. Shop and Machinery Storage Building, on the C.S.U. Agronomy Research Center. (Photo no. 193-27).



## RHIZOCTONIA RESISTANCE BREEDING INVESTIGATIONS, 1969

J. O. Gaskill and E. G. Ruppel

Because of problems related to the preparation and occupancy of new facilities, the Rhizoctonia field work at Fort Collins was curtailed in 1969. One replicated field test of sugarbeet strains for evaluation of Rhizoctonia resistance was conducted on the Warren Tract near Fort Collins. Selection of mother beets for resistance and production of seed by selected beets were continued on a modest scale. A preliminary study, begun in 1968, on the inheritance of Rhizoctonia resistance, was expanded in 1969 by means of leaf spot resistance evaluation plots at Fort Collins and curly top resistance evaluation plots at Logan, Utah. The curly top resistance work in this study was performed by D. L. Mumford, Research Plant Pathologist, Crops Research Division, stationed at Logan. Stecklings, turned over to R. J. Hecker at Fort Collins in the spring of 1969, were used in the development of additional hybrid material, in preparation for a more intensive study on the inheritance of Rhizoctonia resistance in 1970. Work was begun in 1969 on the collection, identification, and pathogenicity characterization of isolates of Rhizoctonia (see separate report by E. G. Ruppel). Some of these isolates are to be used in a new study in 1970 on the interaction of sugarbeet strains x Rhizoctonia isolates.

### Evaluation of Rhizoctonia Resistance

The 12 sugarbeet strains or varieties listed in Table 1 were grown in an equalized random block experiment (no. R-1), involving plots 2 rows x 25 feet in size, with six replications. Rows were 22 inches apart, and plants were thinned to a spacing of about 10 inches in the row. Thinned stands were excellent throughout the entire experiment. All plants in a 16-foot section of each plot were inoculated, approximately 4 weeks after thinning, by means of the rosette method, using a highly pathogenic isolate (B-6) of R. solani. At harvest, each plant in the inoculated portion of each plot was classified as to severity of Rhizoctonia attack as illustrated in Figure 1.

The summarized results of this experiment are presented in Table 1, and a striking contrast in resistance is shown in Figure 2. Rhizoctonia attack was unusually severe in this experiment. As indicated in Table 1, the following check entries were nearly wiped out: US H20, GW 674-56C, US H9B, and SP 5822-0. All six of the "FC" strains--products of Rhizoctonia resistance breeding--were quite significantly superior to those four checks, according to Duncan's Multiple Range Test (1% level). FC 701/2 was particularly attractive in resistance (Table 1 and Figure 2) and was significantly better than most of the other "FC" strains (5% level). The ranking of Zwaanpoly (5th from the lowest in average disease index) is somewhat puzzling. We understand

that this variety has had no background of Rhizoctonia resistance breeding. It is known to be unusually high in beet yield. We believe that this fact, alone, resulted in a tendency toward lower percentages of rotted tissue and thus toward lower grade ratings for the individual diseased plants. The following total numbers of plants classified as "0" (essentially healthy) at harvest support this belief:

Strain	No. of plants	Strain	No. of plants
US H20	0	FC 702	16
GW 674-56C	1	FC 702/2	16
US H9B	1	FC 701	21
SP 5822-0	6	FC 702 (Oreg.)	26
C 817	7	FC 701 (Oreg.)	27
Zwaanpoly	7	FC 701/2	30

All of the strains at the right, above, are products of Rhizoctonia resistance breeding at Fort Collins. Those at the left are considered as having no background of Rhizoctonia resistance breeding. It is of special interest that, according to these numbers: (a) differences among the strains at the left were relatively small; and (b) that group of strains, as a whole, apparently was distinctly inferior to the "FC" strains, in Rhizoctonia resistance, under the conditions of this experiment.

Breeding for Combined Resistance to  
Leaf Spot, Curly Top, and Rhizoctonia

A manuscript by J. O. Gaskill, D. L. Mumford, and E. G. Ruppel, pertaining to the above subject, currently is in the review process. The summary of this article is as follows:

"Replicated sugarbeet field experiments were conducted at Fort Collins, Colorado, in 1968 and 1969 and at Logan, Utah, in 1969 as parts of a preliminary study on the inheritance of resistance to Rhizoctonia root and crown rot and on the feasibility of combining resistance to leaf spot, curly top, and Rhizoctonia.

"With respect to Rhizoctonia, the results obtained for one F<sub>1</sub> hybrid indicated partial dominance of resistance. The resistance of a similar F<sub>1</sub> hybrid was loosely classed as intermediate. Results for a series of 18 F<sub>3</sub> populations indicated, tentatively, that Rhizoctonia resistance can be transferred from resistant to susceptible material with relative ease.

Table 1. Comparison of sugarbeet strains for resistance to Rhizoctonia, Fort Collins, Colorado, 1969; results presented as 6-plot averages (Experiment R-1)<sup>1/</sup>.

Entry no.	Strain	Description	D.I. <sup>2/</sup>	Duncan's test <sup>3/</sup>	
				1%	5%
912	Acc. 2705	US H20	4.38	a	a
901	Acc. 2168	GW 674-56C	4.35	ab	a
911	Acc. 2706	US H9B	4.23	ab	a
910	Acc. 2703	SP 5822-0	4.15	ab	ab
905	SP 621220HO	C 817	3.68	bc	bc
903	Acc. 2708	FC 701 (Oreg.)	3.30	cd	cd
906	SP 681009-0	FC 702	3.15	cde	cd
909	Acc. 2710	Zwaanpoly	3.12	cde	d
902	SP 681008-0	FC 701	3.05	cde	d
908	SP 671008-0	FC 702/2	3.03	cde	d
907	Acc. 2709	FC 702 (Oreg.)	2.88	de	de
904	SP 671007-0	FC 701/2	2.53	e	e

<sup>1/</sup> The plots were planted on 6/2, inoculated on 7/29, and harvested on 10/2.

<sup>2/</sup> D.I. (disease index) based on a scale of 0 to 5; 0 = essentially healthy; 5 = dead.

<sup>3/</sup> Duncan's multiple range test: D.I. means followed by the same letter are not significantly different at the level of significance indicated.

"On the basis of results obtained for the F<sub>3</sub> populations in all three experiments, the following tentative conclusions were drawn: (a) Resistance to leaf spot, curly top, and Rhizoctonia root and crown rot is inherited independently; and (b) combining genetic resistance to these three diseases, in the same sugarbeet strain, is feasible."



Fig. 1. Rhizoctonia grades, from left to right: 0, 1, 2, 3, 4, 5. Grade 0 = essentially healthy; 5 = dead. (Photo. by E. G. Ruppel).



Fig. 2. Comparison of US H9B (left) and FC 701/2 in resistance to Rhizoctonia, Fort Collins, Colorado, September 2, 1969. Plots are two rows wide. (Photo by E. G. Ruppel).



## GROWTH AND CULTURAL CHARACTERISTICS OF SEVERAL RHIZOCTONIA ISOLATES FROM SUGARBEET

E. G. Ruppel

### Introduction

The morphological, physiological, and pathological diversity of Rhizoctonia solani Kuehn isolates from root- or crown-rotted or foliar-blighted sugarbeets is well documented (2, 3, 4). However, little is known about the physiologic specialization of the pathogen with regard to possible interactions among resistant and susceptible strains of beets. Such information would be extremely important to breeders and pathologists working toward resistance to Rhizoctonia.

Substantial gains in resistance of sugarbeet to Rhizoctonia have been made at Fort Collins, Colorado (1); however, most selections have been based on the response of lines to only one isolate of the pathogen. Consequently, a study was begun to determine if different pathogenic races of R. solani exist in Colorado, and to test the reaction of resistant and susceptible lines to the divergent isolates.

This report will cover linear growth rate and cultural characteristics of several Rhizoctonia isolates. Future work will deal with morphological and pathological comparisons.

### Methods

Seven isolates of R. solani were obtained from diseased beets grown in widely scattered areas of Colorado east of the Continental Divide, whereas two isolates were from beets grown near Willcox, Arizona. Isolates R-1, R-2, R-3, R-4, R-8, and R-9 were recovered from partially rotted sugarbeet roots; R-5 was isolated from a beet with crown rot symptoms; R-6 and R-7 were isolated from sugarbeet foliage with symptoms of foliar blight (2). Only R-7 and R-8 were cultured from beets grown in Arizona. R-9 (= B-6) has been used for creating epidemics of root rot in breeding nurseries at Fort Collins for several years. All isolates were maintained in test tubes on potato-dextrose agar (PDA) or on moist, whole barley grain.

The rate of growth for all isolates was obtained by measuring the daily increase in diameter of colonies on PDA (containing 1 g yeast extract/liter) (PDA-YE) at 24 C. Cultures were initiated with 4-mm diam discs from the margins of young PDA-YE cultures. A completely randomized design was used with each isolate appearing 13 times. The rapid growth of some isolates only permitted three daily measurements.

Cultural characteristics were recorded at 1, 3, and 7 days after plating.

### Results

Table 1. Growth of Rhizoctonia solani isolates grown at 24 C on potato dextrose agar containing 1 g yeast extract/liter (PDA-YE)

Isolate	Colony diameter by indicated day <sup>1/</sup>			Linear growth rate <sup>3/</sup> mm/day
	1 day	2 days	3 days <sup>2/</sup>	
	mm	mm	mm	
R-1	14.9 e	32.7 cd	54.6 e	9.9
R-2	12.8 g	29.5 e	52.7 f	10.0
R-3	13.9 ef	33.2 c	57.3 d	10.9
R-4	13.2 fg	33.2 c	57.5 d	11.1
R-5	20.6 a	49.4 b	77.4 c	14.2
R-6	16.6 c	50.4 b	87.4 b	17.7
R-7	17.8 b	52.3 a	90.9 a	18.3
R-8	14.0 ef	29.2 e	50.6 f	9.2
R-9	16.1 d	31.4 d	52.1 f	9.0

<sup>1/</sup> Means of 13 samples; means followed by the same letter are not significantly different at the 5% level as determined by Duncan's Multiple Range Test.

<sup>2/</sup> C.V. for analysis of growth at 3 days = 3.5%.

<sup>3/</sup> Growth rates in mm/day were calculated from average radial growth occurring between 1 and 3 days after plating on medium.

Growth.--An analysis of variance indicated that differences in growth among isolates were highly significant. Duncan's Multiple Range Test on growth at 3 days after plating (Table 1) revealed that the foliar isolates (R-6, R-7) grew more than all other isolates; differences between R-6 and R-7 also were significant. R-5, the crown rot isolate, outgrew all isolates except R-6 and R-7. Differences in growth between R-3 and R-4 were not significant, but both grew more than R-1, R-2, R-8, and R-9. Root-rot isolates R-2, R-8, and R-9 grew the least as compared to all other isolates. Growth rates generally corresponded to total growth.

The interaction, isolates X days, also was highly significant which indicated that the isolates behaved differently from one day to the next. R-5, for example, grew significantly more in the first 24 hr than all other isolates, but at 72 hr this isolate ranked third.

Cultural characteristics.--At 1 to 2 days after plating, all isolates had developed circular colonies composed of relatively dense, appressed, hyaline mycelium. At 3 days, the colonies remained appressed with very sparse aerial mycelium but pigmentation of some isolates was evident. Colonies of R-1 and R-8 were very light tan, but R-8 exhibited more distinct concentric zonation. R-2, R-3, R-4, and R-9 were a darker tannish-brown with well defined lighter zonate rings. R-5 was whitish and powdery in appearance with conspicuous concentric zonation. R-6 and R-7 also were whitish and powdery, but with fewer and less distinct zonate rings than R-5. At 7 days, isolates R-2, R-3, R-4, and R-9 were dark reddish brown with tannish sclerotial primordia forming over the surface of the colonies. R-1 was similar except significantly more and lighter colored sclerotial primordia were apparent. Isolates R-5, R-6, and R-7 were powdery white with little, if any, aerial mycelium or sclerotial primordia. Mycelium of R-8 was a very light buff color with only a few sclerotial primordia. All isolates except R-5, R-6, R-7, and R-8 had sparse to moderate, dark brown, wooly aerial mycelium.

#### Discussion

Cultural appearances and significant differences in growth among several isolates of R. solani from diseased sugarbeets indicated that divergent populations (races?, biotypes?) of the fungus exist in Colorado and Arizona. However, future pathogenicity studies and the responses of different beet strains to the isolates can only determine their importance in a breeding program for resistance to Rhizoctonia. If, for example, there is no significant isolate X beet strain interaction, then the use of only the most virulent isolate in selection plots would be justified. A significant interaction, however, would necessitate the use of mixed isolates in creating field epiphytotics. In either case, resistant selections of beets from Colorado must be tested in other areas where Rhizoctonia root rot is prevalent.

#### Summary

Significant differences in growth and different cultural characteristics among isolates of Rhizoctonia solani from diseased sugarbeet specimens indicated that divergent populations (races?) of the fungus exist in Colorado and Arizona. Root-rot, crown-rot, and foliar isolates were easily distinguished by their growth habits.

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#### INHERITANCE OF RESISTANCE TO CERCOSPORA LEAF SPOT IN SUGARBEET

Garry A. Smith and John O. Gaskill

Estimates of the heritability of resistance to Cercospora leaf spot in sugarbeet and the number of genes controlling resistance were made, using data obtained for nine sugarbeet populations in 1959 and 1960. The leaf spot susceptible inbred lines, 51-319 and 52-334, and the leaf spot resistant line, US 201, were utilized along with their  $F_1$  and  $F_2$  populations. Individual-plant leaf spot ratings were made on 2880 plants in a randomized block experiment with 40 replications in each of the two years.

Frequency distributions of the  $F_2$  plants clearly indicated that resistance behaves as a quantitative character and that no conventional Mendelian ratio could be expected. Estimates of the number of genes controlling resistance were made by use of the Castle-Wright formula which is a commonly used statistical formula for estimating the minimum number of genes governing a quantitative character.

Results indicated that a minimum of 4 or 5 pairs of genes control resistance to leaf spot and that more genes may be active under severe epidemic conditions than under less severe conditions.

Heritability of Resistance.--Variances of the parents and the  $F_2$  populations provided a means of estimating heritability of resistance, or the relative proportion of variation in the segregating populations which was genetic. This information can be used in determining how effective selection for high leaf spot resistance among individual  $F_2$  plants will be. The statistical measure of the degree to which the  $F_2$  variance exceeded the average variance of the parents was used as a measure of heritability, on the assumption that the difference was an indication of the genetic variance in  $F_2$ . The heritability values for the two years ranged from 60 to 71 percent. These values are relatively high and indicate that a high proportion of the variation among  $F_2$  plants was genetic in nature. It must be emphasized, however, that these broad sense estimates of heritability are not exact measures of the effectiveness of selection in the  $F_2$  but are suggestive of the positive relationship between phenotype and genotype of the  $F_2$  plants.

Additional studies are planned to further explain the inheritance of leaf spot resistance and to compare predicted genetic advance with actual advance by selection.

A full report on the study summarized above has been prepared for publication in the Journal of the American Society of Sugar Beet Technologists.



DEVELOPMENT AND EVALUATION OF SUGARBEET BREEDING MATERIAL AND  
VARIETIES WITH RESISTANCE TO BOTH LEAF SPOT AND CURLY TOP, 1969 <sup>1/</sup>

J. O. Gaskill and E. G. Ruppel

Objectives of this "LSR-CTR" project in 1969 were essentially the same as in the recent past. The total amount of work performed at Fort Collins in 1969 was less than in 1968 and work on certain phases of the project was temporarily suspended because of problems related to the preparation and occupancy of new facilities. Evaluation of experimental hybrids (so-called "LSR-CTR varieties") by cooperators at other locations constituted an important part of the total effort on this project.

Field work under leaf spot conditions at Fort Collins in 1969 included agronomic top-cross and reciprocal top-cross tests; an agronomic cooperative test of LSR-CTR varieties; observational tests of numerous sugar company lines; observational tests of miscellaneous monogerm type-0 lines, experimental hybrids and other material; and selection of breeding material. Steckling production, reproduction, and hybridization were included in the 1969 work program. Bagging was suspended.

The results of various tests will be used for future guidance in the research program at Fort Collins. Only those results pertaining to the cooperative evaluation of LSR-CTR varieties are presented in this report.

Cooperative Tests of LSR-CTR Varieties

The varieties described in Table 1 were evaluated in agronomic tests at 10 locations in five states. In addition, observational tests for disease resistance were conducted at four locations in four states. The summarized results of all tests are presented in Tables 2-5, inclusive. The results of individual agronomic tests are shown in Tables 6-15, inclusive.

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<sup>1/</sup> In addition to cooperation indicated elsewhere, assistance of the following Sugarbeet Investigations research scientists, in conducting this project, is gratefully acknowledged: (1) D. L. Mumford, Logan, Utah, for evaluation of the curly top resistance of a large number of lines and experimental hybrids, and for selection of individual plants for curly top resistance; (2) J.C. Theurer, Logan, Utah, for reproduction of curly top resistant selections; (3) G. E. Coe, Beltsville, Maryland, for evaluation of the leaf spot resistance of LSR-CTR varieties; (4) I.O. Skoyen, Salinas, Calif., for selection work in and evaluation of LSR-CTR lines for bolting resistance; (5) G.A. Smith, Fort Collins, Colo., and G.J. Hogaboam, East Lansing, Michigan, for study of and selection work in LSR-CTR material at Salem, Oregon. The authors also are indebted to S. C. Campbell, of the West Coast Beet Seed Company, Salem, Oregon, for assistance in the evaluation and selection work referred to in item "(5)" of the preceding sentence.

In general, the agronomic tests were satisfactory in techniques, stand, and field uniformity. However, most of the tests in the Colorado-Kansas-Texas area were influenced by excessive precipitation late in the season and by untimely, severe freezes in the fall. Sucrose percentage generally was low, and in two tests it was extremely low (general means 8.75 and 5.43 at Hereford, Texas, and Ulysses, Kansas, respectively). A severe leaf spot epidemic was developed at Fort Collins, Colorado, by artificial means. In the agronomic test at Hereford, the normal development of leaf spot was partially prevented by spraying (maneb), and the actual intensity of leaf spot was classed as moderate. Disease effects were considered negligible in all other tests.

Relative 1969 performance of certain varieties, included in this cooperative evaluation program in previous years, was out of line with the earlier results. For this reason, and in view of the fact that the weather conditions in 1969 were so far from normal, generalizations on the basis of 1969 results should be made with caution.

Table 1. Description of material in cooperative evaluation tests of LSR-CTR varieties, 1969. <sup>1/</sup>

Entry no.	Seed no.	Description <sup>2/</sup>
1	Acc. 2705	US H20 [SL(129 x 133) x SP 6322-0]; monogerm; LSR-CTR-BRR; furnished by F & M.
2	SP 671203H08	FC(504 x 502/2) x FC 901; monogerm; LSR-CTR.
3	SP 661204H08	FC(504 x 502/2) x McF. 663; monogerm; LSR-CTR.
4	SP 681203H017	(FC 602 x SP 632028s1) x FC 901; monogerm; LSR-CTR.
5	SP 681204H017	(FC 602 x SP 632028s1) x McF. 663; monogerm; LSR-CTR.
6	SP 681900H06	FC 504 x FC 901; monogerm; LSR-CTR.
7	SP 681201H05	FC(504 x 502/2) x SP 6322-0; monogerm; <u>LSR check</u> .
8	Acc. 2706	US H9B; monogerm; resistant to curly top, virus yellows, and bolting; <u>CTR check</u> ; furnished by J. S. McFarlane.

<sup>1/</sup> A "local check", furnished by the cooperator, was included in certain tests in addition to the varieties listed in this table.

<sup>2/</sup> The following symbols pertain to loose, initial classification for disease resistance: BRR = black root resistant (i.e. resistant to Aphanomyces-type black root); CTR = curly top resistant; LSR = resistant to Cercospora leaf spot.

Table 2. Summary of harvest results, cooperative agronomic evaluation tests of LSR-CTR varieties, 1969; as percent of the standard variety, US H20.

Test no., state, and locality	Leaf <sup>1/</sup> spot	No. reps	Gross Sucrose Yield								Loc. <sup>2/</sup> ck.	LSD <sup>3/</sup> (.05)
			1	2	3	4	5	6	7	8		
(1) Calif., Hamilton City		8	100	101	109	110	109	96	96	125		13
(2) Calif., Tracy		9	100	100	97	103	106	90	87	96		10
(3) Colo., Fort Collins	3	9	100	104	94	85	89	99	111	81	104	9
(4) Colo., Longmont		6	100*	113*	106*	91*	99*	83*	107*	97*	104*	11*
(5) Colo., Rocky Ford		8	100	100	88	99	103	98	96	96		11
(6) Colo., Two Buttes <sup>4/</sup>		8	100	111	109	96	107	104	110	113		11
(7) Kansas, Ulysses <sup>4/</sup>		8	100	98	103	84	97	91	92	85		18
(8) Minn., Bird Island		8	100	92	96	83	88	97	100	89		8
(9) Minn., E. Grand Forks		8	100	96	96	87	88	96	95	97		3
(10) Texas, Hereford	2	9	100	90	104	86	89	98	106	98	98	17
Average - all tests			100.0	100.5	100.2	92.4	97.5	95.2	100.0	97.7		
Av. - western tests(i.e.excl.#8 & #9)			100.0	102.1	101.3	94.3	99.9	94.9	100.6	98.9		

- <sup>1/</sup> Leaf spot exposure scale: 1 = mild; 2 = moderate; 3 = severe. Other diseases were considered negligible in all tests.
- <sup>2/</sup> Local checks were as follows (test numbers in parentheses): (3) GW 674-56C; (4) GW 761-60R; (10) HH 10.
- <sup>3/</sup> LSD (.05) expressed as percent of the gross sucrose yield of the standard variety (entry no. 1).
- <sup>4/</sup> Results obtained at Ulysses, Kansas, are of questionable value because of extremely low sucrose percentages (average 5.43).
- \* = Recoverable sucrose.

Table 3. Summary of harvest results, cooperative agronomic evaluation tests of LSR-CTR varieties, 1969; as percent of the standard variety, US H20.

Test no., state, and locality	Leaf <sup>1/</sup> spot	No. reps	Beet Yield								Loc. <sup>2/</sup> ck.	LSD <sup>3/</sup> (.05)
			1	2	3	4	5	6	7	8		
(1) Calif., Hamilton City	B	8	100	100	106	104	105	101	97	122	11	
(2) Calif., Tracy		9	100	97	97	103	107	93	92	108	7	
(3) Colo., Fort Collins	3	9	100	101	98	86	93	106	106	87	95	6
(4) Colo., Longmont		6	100	104	100	88	93	95	99	106	98	11
(5) Colo., Rocky Ford		8	100	97	88	95	100	101	94	101	10	
(6) Colo., Two Buttes		8	100	110	111	94	105	111	111	118	10	
(7) Kansas, Ulysses		8	100	101	107	85	98	111	102	102	10	
(8) Minn., Bird Island		8	100	91	93	85	89	98	99	92	8	
(9) Minn., E. Grand Forks		8	100	96	99	89	92	98	99	102	3	
(10) Texas, Hereford	2	9	100	93	107	85	90	110	103	106	104	15
Average - all tests			100.0	99.0	100.6	91.4	97.2	102.4	100.2	104.4		
Av. - western tests (i.e. excl. #8 & #9)			100.0	100.4	101.8	92.5	98.9	103.5	100.5	106.3		

1/ Leaf spot exposure scale: 1 = mild; 2 = moderate; 3 = severe. Other diseases were considered negligible in all tests.

2/ Local checks were as follows (test numbers in parentheses): (3) GW 674-56C; (4) GW 761-60R; (10) HH 10.

3/ LSD (.05) expressed as percent of the beet yield of the standard variety (entry no. 1).



Table 4. Summary of harvest results, cooperative agronomic evaluation tests of LSR-CTR varieties, 1969; as percent of the standard variety, US H20.

Sucrose Percentage												
Test no., state, and locality	1/ Leaf spot	No. reps	Entry no.								Loc. ck.	LSD <sup>3/</sup> (.05)
			1	2	3	4	5	6	7	8		
(1) Calif., Hamilton City		8	100	101	103	105	103	96	99	102		5
(2) Calif., Tracy		9	100	103	100	100	99	96	93	89		7
(3) Colo., Fort Collins	3	9	100	102	96	99	96	94	105	94	110	5
(4) Colo., Longmont		6	100	108	104	102	105	90	106	95	107	5
(5) Colo., Rocky Ford		8	100	104	100	104	103	97	103	96		3
(6) Colo., Two Buttes		8	100	102	98	103	102	94	99	96		4
(7) Kansas, Ulysses <sup>4/</sup>		8	100	97	95	98	100	81	90	84		13
(8) Minn., Bird Island		8	100	101	103	98	99	99	101	96		3
(9) Minn., E. Grand Forks		8	100	100	98	98	97	98	96	95		2
(10) Texas, Hereford	2	9	100	97	97	100	99	90	105	93	95	7
Average - all tests			100.0	101.5	99.4	100.7	100.3	93.5	99.7	94.0		
Av. - western tests (i.e., excl. #3 & #9)			100.0	101.8	99.1	101.4	100.9	92.3	100.0	93.6		

<sup>1/</sup> Leaf spot exposure scale: 1 = mild; 2 = moderate; 3 = severe. Other diseases were considered negligible in all tests.

<sup>2/</sup> Local checks were as follows (test numbers in parentheses): (3) GW 674-56C; (4) GW 761-60R; (10) HH 10.

<sup>3/</sup> LSD (.05) expressed as percent of the sucrose percentage of the standard variety (entry no. 1).

<sup>4/</sup> Results obtained at Ulysses, Kansas, are of questionable value because of extremely low sucrose percentages (average 5.43).

Table 5. Summary of leaf spot and curly top resistance results, cooperative tests of LSR-CTR varieties, 1969; disease exposure intensified artificially in each test.

Entry no.	Seed no.	Description	Leaf spot grades $\frac{1}{9/5}$				Curly top grades $\frac{2}{4/}$			
			No. of replications	Ft. Col. 3/9/5	Heref. 4/Tex.	Belts. Md. 3/	Aver.	Logan 3/Utah	Sher. 4/Wyo.	Aver.
1	Acc. 2705	US H20		4,9	3,0	5,2	4,4	6,0	6,0	6,0
2	SP 671203H08	FC(504 x 502/2)x FC 901		4,6	2,0	4,5	3,7	6,5	6,0	6,3
3	SP 661204H08	FC(504 x 502/2)x McF. 663		4,8	2,0	4,3	3,7	5,5	6,0	5,8
4	SP 681203H017	(FC 602 x SP 632028s1)x FC 901		4,0	3,5	5,1	4,2	4,5	5,0	4,8
5	SP 681204H017	(FC 602 x SP 632028s1)x McF. 663		5,1	2,5	5,1	4,2	5,0	5,5	5,3
6	SP 681900H06	FC 504 x FC 901		4,1	2,5	4,4	3,7	6,0	6,0	6,0
7	SP 681201H05	FC(504 x 502/2)x SP 6322-0		3,3	2,0	3,4	2,9	6,5	5,5	6,0
8	Acc. 2706	US H9B		5,6	4,0	6,2	5,3	5,0	5,0	5,0
		GW 674-56C		5,4						
		HH 10			4,0				6,5	
		SP 65555-1 x SP 6322-0				4,8				
		US 41						5,3		

1/ Scale at Hereford, 1-5 (lower number = greater resistance). At Fort Collins and Beltsville, 0 = no leaf spot and 10 = complete defoliation.

2/ At Logan, 0 = healthy and 9 = dead. Scale at Sheridan, 1-10 (lower number = greater resistance).

3/ Test conducted by Sugarbeet Investigations, ARS, USDA.

4/ Test conducted by Holly Sugar Corporation.

Table 6. Cooperative agronomic test of LSR-CTR varieties, 1969  
Location: Hamilton City, California

Seed no. or variety	Entry no.	Acre yield		Sucrose	Plants per 100'
		Gross sucrose	Beets		
		Lbs.	Tons	%	No.
Acc. 2705	1	5424	17.79	15.26	205
SP 671203H08	2	5497	17.84	15.34	187
SP 661204H08	3	5931	18.85	15.71	183
SP 681203H017	4	5941	18.52	16.04	183
SP 681204H017	5	5906	18.76	15.66	167
SP 681900H06	6	5226	17.93	14.59	196
SP 681201H05	7	5219	17.21	15.14	193
Acc. 2706	8	6758	21.74	15.52	185
General mean		5738.	18.58	15.41	188.
S.E. of var. mean		245.	0.69	0.27	
LSD (.05)		696.3	1.97	0.77	

Conducted by: Holly Sugar Corporation, Tracy, California  
Dr. D. D. Dickenson and Dr. J. L. Purdy

Dates of Planting and Harvest: Planted - April 17, 1969  
Harvested - October 2, 1969

Experimental Design: Randomized Complete Block  
8 Replications

Determination of Beet Yield and Sucrose Percentage:

Yield - Entire Plot (2-30 inch rows x 50 feet)  
% Sucrose - 2-25lb. Samples per Plot

Leaf Spot Exposure: None

Curly Top Exposure: None

Other Diseases and Pests: None

Reliability of Test and Remarks: Fair test. Too many skips. Yield was very poor in rest of field.

Table 7. Cooperative agronomic test of LSR-CTR varieties, 1969  
Location: Tracy, California

Seed no. or variety	Entry no.	Acre yield		Sucrose	Plants per 100'
		Gross sucrose	Beets		
		<u>Lbs.</u>	<u>Tons</u>	<u>%</u>	<u>No.</u>
Acc. 2705	1	7911	32.52	12.20	126
SP 671203HO8	2	7903	31.52	12.55	119
SP 661204HO8	3	7679	31.54	12.17	122
SP 681203HO17	4	8170	33.39	12.23	117
SP 681204HO17	5	8360	34.79	12.05	115
SP 681900HO6	6	7136	30.09	11.76	116
SP 681201HO5	7	6894	29.92	11.39	122
Acc. 2706	8	7581	35.05	10.80	127
General mean		7705.	32.35	11.90	121.
S.E. of var. mean		280.	0.77	0.28	
LSD (.05)		791.3	2.19	0.80	

Conducted by: Holly Sugar Corporation, Tracy, California  
Dr. D. D. Dickenson and Dr. J. L. Purdy

Dates of Planting and Harvest: Planted - May 14, 1969  
Harvested - October 21, 1969

Experimental Design: Randomized Complete Block  
9 Replications

Determination of Beet Yield and Sucrose Percentage:  
Yield - Entire Plot (2-30 inch rows x 50 feet)  
% Sucrose - 2-25 lb. Samples per Plot

Leaf Spot Exposure: None

Curly Top Exposure: None

Other Diseases and Pests: None

Reliability of Test and Remarks: Good test. Too many skips.



Table 8. Cooperative agronomic test of LSR-CTR varieties, 1969  
Location: Warren Tract, Fort Collins, Colorado (Exp. 1A)

Seed no. or variety	Entry no.	Acre yield		Sucrose	Plants per 100 <sup>1</sup>	Leaf spot <sup>1/</sup>	
		Gross sucrose	Beets			8/26	9/5
		Lbs.	Tons			%	No.
Acc. 2705	1	3034	12.73	11.85	120	3.7	4.9
SP 671203H08	2	3145	12.91	12.14	119	3.4	4.6
SP 661204H08	3	2839	12.41	11.39	118	3.1	4.8
SP 681203H017	4	2583	10.90	11.69	118	3.7	4.0
SP 681204H017	5	2705	11.88	11.34	120	4.1	5.1
SP 681900H06	6	3012	13.47	11.12	117	3.2	4.1
SP 681201H05	7	3358	13.49	12.41	118	1.8	3.3
Acc. 2706	8	2469	11.07	11.10	123	5.6	5.6
GW 674-56C	9	3148	12.03	13.06	121	4.0	5.4
General mean		2921	12.32	11.79	120	3.6	4.6
S.E. of var. mean		91.7	0.272	0.21	1.47	0.19	0.14
LSD (.05)		260	0.77	0.60	4	0.5	0.4

<sup>1/</sup> Basis of leaf spot grades: 0 = healthy; 10 = complete defoliation.

Conducted by: J. O. Gaskill, E. G. Ruppel, and L. W. Lawson

Dates of Planting and Harvest: May 14-15; October 7.

Experimental Design: Latin Square (9 x 9); plots 2 rows x 22'; rows 22" apart.

Determination of Beet Yield and Sucrose Percentage: All beets in an accurately measured competitive-stand area (about 36 ft. of row) in each plot were topped, washed, and weighed; then divided into two samples for sucrose analyses.

Leaf Spot Exposure: Severe (intensified artificially).

Curly Top Exposure: Negligible

Other Diseases and Pests: Negligible

Reliability of Test: Very good

Table 9. Cooperative agronomic test of LSR-CTR varieties, 1969  
Location: Mayeda Farm, Longmont, Colorado  
(Averages given as % of GW 761-60R, except beets per 100')<sup>1/</sup>

Seed no. or variety	Entry no.	Acre yield		Sucrose %	Thin juice app. purity	Beets per 100' <sup>2/</sup>
		Recov. sucrose	Beets			
Acc. 2705	1	95.92	101.81	93.64-	100.64	104
SP 671203H08	2	108.32	106.16	101.03	100.67	108
SP 661204H08	3	101.66	102.22	97.50	101.02+	103
SP 681203H017 <sup>3/</sup>	4	87.70-	90.09	95.55-	101.21+	100
SP 681204H017	5	94.57	95.00	98.07	101.05+	100
SP 681900H06 <sup>3/</sup>	6	79.87-	97.14	83.94-	99.37	104
SP 681201H05	7	102.22	100.96	99.04	101.19+	104
Acc. 2706	8	93.49	107.74	88.63-	99.36	111
C. V. (%)		9.50	9.13	3.69	0.67	
LSD (.05) as % of GW 761		10.86	11.10	4.28	0.82	

+ Significantly above GW 761 at 5% point.

- Significantly below GW 761 at 5% point.

<sup>1/</sup> Means for GW 761-60R were as follows: Recoverable sucrose, 4440 lbs. per acre; Beets, 17.16 tons per acre; Sucrose %, 13.91; Purity %, 97.21.

<sup>2/</sup> Number of beets harvested.

<sup>3/</sup> Frost susceptible.

Conducted by: Great Western Sugar Co. (Alvin Erichsen, Akio Suzuki, and Dave Rademacher).

Dates of Planting and Harvest: April 11; November 13.

Experimental Design: Triple Lattice; 6-row plots; 6 replicates.

Leaf Spot Exposure: Negligible

Curly Top Exposure: Negligible

Other Diseases and Pests: Nematodes were present in parts of the field, even after fumigation, but not severe.

Reliability of Test and Remarks: Satisfactory test. Severe freezes occurred, beginning early in October.

Table 10. Cooperative agronomic test of LSR-CTR varieties, 1969  
Location: Rocky Ford, Colorado - Test #945-02

Seed no. or variety	Entry no.	Acre yield			Beets	Sucrose	Impurity index
		Gross sucrose					
		Actual	-KSL*				
		Lbs.	Lbs.	Tons			
Acc. 2705	1	5803	4987	23.58	12.35	936	
SP 671203HO8	2	5829	4995	22.80	12.82	953	
SP 661204HO8	3	5086	4291	20.66	12.36	1033	
SP 681203HO17	4	5741	5006	22.34	12.90	849	
SP 681204HO17	5	5958	5127	23.56	12.71	924	
SP 681900HO6	6	5671	4887	23.81	11.95	1151	
SP 681201HO5	7	5599	4873	22.15	12.66	862	
Acc. 2706	8	5598	4723	23.71	11.81	1048	
General Mean		5661	4836	22.83	12.44	970	
C. V. %		10.72	11.11	10.18	2.60	8.05	
LSD (.05)		612	542	2.34	.33	78	

\* = Gross sucrose minus known sugar loss.

Conducted by: American Crystal Sugar Company

Dates of Planting and Harvest: April 30 and May 1; November 6.

Experimental Design: Latin Square, 8 x 8; plots 2 rows x 35';  
22-inch rows.

Leaf Spot Exposure: Negligible

Curly Top Exposure: Negligible

Other Diseases and Pests: Negligible

Reliability of Test: Good

Table 11. Cooperative agronomic test of LSR-CTR varieties, 1969  
Location: Two Buttes, Colorado - Test #945-03

Seed no. or variety	Entry no.	Acre yield			Sucrose	Impurity index
		Gross sucrose		Beets		
		Actual	-KSL*			
		<u>Lbs.</u>	<u>Lbs.</u>	<u>Tons</u>	<u>%</u>	
Acc. 2705	1	5637	5111	22.02	12.75	628
SP 671203H08	2	6261	5674	24.16	12.97	627
SP 661204H08	3	6126	5475	24.48	12.52	705
SP 681203H017	4	5422	4975	20.65	13.15	548
SP 681204H017	5	6008	5439	23.19	12.97	635
SP 681900H06	6	5844	5189	24.39	12.02	747
SP 681201H05	7	6191	5589	24.51	12.62	650
Acc. 2706	8	6366	5663	25.99	12.26	739
General mean		5982	5389	23.67	12.66	660
C. V. %		9.86	9.96	9.27	3.71	8.77
LSD (.05)		592	540	2.21	.47	58

\* = Gross sucrose minus known sugar loss.

Conducted by: American Crystal Sugar Company

Dates of Planting and Harvest: April 15; October 6-7.

Experimental Design: Latin Square, 8 x 8; plots 2 rows x 35';  
24-inch rows.

Leaf Spot Exposure: Negligible

Curly Top Exposure: Negligible

Other Diseases and Pests: Negligible

Reliability of Test: Good



Table 12. Cooperative agronomic test of LSR-CTR varieties, 1969  
Location: Ulysses, Kansas - Test #945-04

Seed no. or variety	Entry no.	Acre yield			Beets	Sucrose	Impurity index
		Gross sucrose					
		Actual	-KSL*				
		<u>Lbs.</u>	<u>Lbs.</u>	<u>Tons</u>	<u>%</u>		
Acc. 2705	1	2573	1527	21.92	5.84	2766	
SP 671203H08	2	2529	1432	22.06	5.65	2995	
SP 661204H08	3	2640	1445	23.45	5.56	3187	
SP 681203H017	4	2174	1268	18.60	5.70	3050	
SP 681204H017	5	2500	1440	21.41	5.82	2847	
SP 681900H06	6	2331	1051	24.33	4.72	3849	
SP 681201H05	7	2359	1272	22.37	5.25	3120	
Acc. 2706	8	2189	1076	22.30	4.92	3405	
General mean		2412	1314	22.05	5.43	3152	
C. V. %		19.51	31.67	10.16	13.33	16.41	
LSD (.05)		473	418	2.25	.73	520	

\* = Gross sucrose minus known sugar loss.

Conducted by: American Crystal Sugar Company

Dates of Planting and Harvest: April 28; November 3 and 4.

Experimental Design: Latin Square, 8 x 8; plots 2 rows x 35';  
22-inch rows.

Leaf Spot Exposure: Negligible

Curly Top Exposure: Negligible

Other Diseases and Pests: Negligible

Reliability of Test and Remarks: From the standpoint of techniques, the test was good. However, in view of the extremely low sucrose percentages, the results are of questionable value. The low sucrose level presumably was due, at least in part, to excessive, prolonged wet weather in September and October.

Table 13. Cooperative agronomic test of LSR-CTR varieties, 1969  
Location: Bird Island, Minnesota - Test #965-02

Seed no. or variety	Entry no.	Acre yield			Sucrose	Impurity index
		Gross sucrose		Beets		
		Actual	-KSL*			
		<u>Lbs.</u>	<u>Lbs.</u>	<u>Tons</u>	<u>%</u>	
Acc. 2705	1	5894	5277	19.01	15.51	698
SP 671203H08	2	5432	4870	17.38	15.62	689
SP 661204H08	3	5658	5040	17.72	15.98	727
SP 681203H017	4	4886	4419	16.07	15.22	637
SP 681204H017	5	5176	4633	16.85	15.39	698
SP 681900H06	6	5721	5095	18.71	15.32	730
SP 681201H05	7	5890	5310	18.88	15.64	651
Acc. 2706	8	5219	4578	17.48	14.94	822
General Mean		5484	4903	17.76	15.45	706
C. V. %		8.56	8.50	8.74	3.03	6.64
LSD (.05)		474	420	1.56	.47	47

\* = Gross sucrose minus known sugar loss.

Conducted by: American Crystal Sugar Company

Dates of Planting and Harvest: May 13-14; September 16-22.

Experimental Design: Latin Square, 8 x 8; plots 2 rows x 35';  
22-inch rows.

Leaf Spot Exposure: Negligible

Curly Top Exposure: Negligible

Other Diseases and Pests: Negligible

Reliability of Test: Good

Table 14. Cooperative agronomic test of LSR-CTR varieties, 1969  
Location: East Grand Forks, Minnesota - Test #985-04

Seed no. or variety	Entry no.	Acre yield			Beets	Sucrose	Impurity index
		Gross sucrose					
		Actual	-KSL*				
		<u>Lbs.</u>	<u>Lbs.</u>	<u>Tons</u>	<u>%</u>		
Acc. 2705	1	6969	6416	22.21	15.69	530	
SP 671203HO8	2	6714	6195	21.33	15.76	513	
SP 661204HO8	3	6701	6109	21.91	15.31	589	
SP 681203HO17	4	6056	5638	19.77	15.33	459	
SP 681204HO17	5	6147	5648	20.51	15.27	541	
SP 681900HO6	6	6706	6152	21.84	15.36	553	
SP 681201HO5	7	6645	6112	21.97	15.13	533	
Acc. 2706	8	6778	6151	22.72	14.93	616	
<hr/>							
General mean		6589	6053	21.49	15.35	542	
C. V. %		3.52	3.72	3.36	2.38	8.71	
LSD (.05)		234	227	.73	.37	47	

\* = Gross sucrose minus known sugar loss.

Conducted by: American Crystal Sugar Company

Dates of Planting and Harvest: May 20; October 15-21.

Experimental Design: Latin Square, 8 x 8; plots 2 rows x 35';  
22-inch rows.

Leaf Spot Exposure: Negligible

Curly Top Exposure: Negligible

Other Diseases and Pests: Negligible

Reliability of Test: Good

Table 15. Cooperative agronomic test of LSR-CTR varieties, 1969  
Location: Hereford, Texas

Seed no. or variety	Entry no.	Acre yield		Sucrose	Plants per 100'	Nitrate	Conduc- tivity
		Gross sucrose	Beets				
		Lbs.	Tons	%	No.	%	
Acc. 2705	1	4840	26.746	8.98	172	.042	13141
SP 671203HO8	2	4352	24.757	8.72	172	.046	13508
SP 661204HO8	3	5041	28.734	8.73	163	.041	13241
SP 681203HO17	4	4142	22.860	9.00	172	.038	12625
SP 681204HO17	5	4286	24.113	8.88	152	.037	14225
SP 681900HO6	6	4752	29.342	8.12	160	.056	15341
SP 681201HO5	7	5147	27.552	9.39	167	.039	14233
Acc. 2706	8	4753	28.358	8.39	174	.040	14183
HH 10	9	4743	27.796	8.51	185	.042	14158
General mean		4672	26.695	8.75	169	.042	13850
S.E. of var. mean		287	1.393	.23		.003	643
LSD (.05)		799	3.881	.64		.009	1792

Conducted by: Holly Sugar Corporation

Dates of Planting and Harvest: Planted 3-15-69  
Harvested 11-10-69

Experimental Design: Randomized Block - 9 replications  
Plot size = single row plots 25' long

Determination of Beet Yield and Sucrose Percentage: Entire plot weighed for yield determination; two ten beet samples taken for sucrose determination.

Leaf Spot Exposure: Moderate - sprayed with Maneb to control leaf spot during growing season.

Curly Top Exposure: Slight

Other Diseases and Pests: Negligible

Reliability of Test and Remarks: Test considered quite uniform and results are classed as quite reliable.



## LONGEVITY OF *CERCOSPORA BETICOLA* INOCULUM UNDER REFRIGERATION

E. G. Ruppel

### Introduction

In evaluations of breeding material for resistance to leaf spot, induced by *Cercospora beticola* Sacc., in the greenhouse, it often is difficult to achieve the proper timing for obtaining maximum spore production in culture when the plants are at an optimum size for inoculation. The ability to store inoculum prepared when cultures are at peak spore production would permit a greater flexibility in inoculation schedules.

Maximum spore production of *C. beticola* grown on sugarbeet leaf extract agar under continuous light at 15 C was found to occur 5 days after "seeding" the medium with a spore-mycelium suspension. The number of recoverable spores dropped substantially on the sixth and seventh days. Thus, 5-day-old cultures always are used when preparing suspensions for inoculations.

Since it is easier to manipulate the fungus cultures rather than the test plants, this study was undertaken to determine if inoculum would remain viable and infectious in suspension under prolonged cold storage.

### Materials and Methods

A spore suspension was prepared in the usual way. Each of 10 5-day-old sporulating cultures was flooded with 10 ml sterile distilled water. The cultures were rubbed gently with a camel's-hair brush and the resultant suspensions were drained, bulked, and diluted to 250 ml with sterile distilled water. A spreader ('Tween 20') was added to a concentration of 1:5000. Hemacytometer counts (six replications) indicated a concentration of 190,000 spores/cc. A portion of the suspension was used immediately to inoculate sugarbeets in the greenhouse and to test the germination of the spores. The remainder of the suspension was placed in a capped 250-ml Erlenmeyer flask and stored in a refrigerator at 2-3 C. Each day the flask was agitated and a small aliquot of the suspension was transferred to a deep-well slide. The slide was placed in a Petri dish with a small amount of water to prevent evaporation. Germination was checked microscopically after a 24-hr incubation period at room temperature. Pathogenicity of the stored inoculum was retested at 14 days by inoculating sugarbeets.

### Results

After 17 days in cold storage, 100% of the spores germinated. From 18 to 28 days, slightly less than 100% (99+%) of the spores

still were viable. Germination dropped sharply to about 50% between 28 and 34 days, at which time the experiment was terminated.

Severe infection of inoculated sugarbeets indicated that the inoculum was highly virulent at 0 and 14 days after preparation.

#### Discussion

The results of this test indicate that spore suspensions of C. beticola can be stored for at least two weeks without loss of viability or pathogenicity.

During the third week of storage some bacterial activity was observed in the germination test slides. And, in the fourth week, clumping of conidia occurred in the stored suspension. No apparent adverse effect on the conidia could be detected, however, until the fifth week when lysis was observed. Conceivably, elimination of bacterial contamination might have prolonged the storage life of the inoculum.

#### Summary

Spores of Cercospora beticola remained pathogenic and 100% viable in aqueous suspension under refrigeration for 14 days. Viability remained near 100% up to 28 days, but declined rapidly between 28 and 34 days. Bacterial contamination after 14 days may have been influential in shortening the longevity of the spores.

GROWTH HABITS OF SINGLE-SPORE ISOLATES OF  
CERCOSPORA BETICOLA ON FIVE AGAR MEDIA

E. G. Ruppel

To determine if pathogenic races of Cercospora beticola Sacc. exist in Colorado, comparative studies of several single-spore isolates were begun. This report will cover growth and cultural characteristics on different media, whereas future work will deal with pathogenicity and possible interactions among isolates of the fungus and strains of beets possessing different degrees of resistance.

Materials and Methods

Fourteen single-spore isolates were obtained from diseased sugar-beet leaves collected in eastern Colorado in 1969 (Table 1). Isolates were obtained from beet lines with various degrees of susceptibility.

Five media were used: a) PDA, potato-dextrose agar, Difco; b) CMA, corn meal agar, Difco; c) V-8 juice agar (2); d) CSA, Czapek's solution agar, Difco; e) SBLEA, sugarbeet leaf extract agar (1).

Colonies were initiated on the test media with 4-mm diam mycelium-agar cylinders from the margins of 1-week-old Petri dish cultures grown on PDA. The dishes were placed on a laboratory bench (three per isolate-medium combination) in a completely randomized design under constant light from fluorescent desk lamps and at a room temperature of 24-26 C.

Table 1. Origin of single-spore isolates of Cercospora beticola from eastern Colorado

Isolate	Source		Resistance of source <sup>1/</sup>
	Line	Field location	
C-1	Pioneer	1969 Leaf spot nursery	S
C-2	NB7	CSU Agronomy farm	S
C-3	SP 6322-0	1969 Leaf spot nursery	R
C-4	52-334	do	S
C-5	US 201	do	R
C-6	US H20	Rocky Ford	R
C-7	GW <sup>2/</sup>	Loveland	R
C-8	do	do	R
C-9	do	Greeley	R
C-10	do	Fort Morgan	R
C-11	do	do	R
C-12	do	do	R
C-13	do	Sterling	R
C-14	do	Brighton	R

<sup>1/</sup> S = susceptible and R = resistant to C. beticola.

<sup>2/</sup> Designation unknown; Great Western commercial line.

Colony diameters were measured (minus 4 mm for the inoculum cylinder) at 4, 8, and 12 days after plating. Data were subjected to analyses of variance and means were separated by Duncan's Multiple Range Test. Cultural characteristics were recorded 12 days after plating.

### Results

Table 2. Growth in 12 days of 14 single-spore isolates of Cercospora beticola from Colorado on 5 agar media <sup>1/</sup>.

Isolate	Growth in millimeters on indicated medium <sup>2/</sup>				
	PDA	CMA	V-8	SBLEA	CSA
C-1	43.3 a	32.7 cd	31.3 c	27.7 d	23.7 a
C-2	43.0 a	29.7 e	38.3 a	32.2 a	26.2 a
C-3	43.3 a	36.2 ab	32.3 c	27.7 d	22.0 a
C-4	42.7 a	37.2 ab	32.3 c	28.0 d	23.3 a
C-5	43.2 a	38.2 a	32.5 c	27.8 d	24.0 a
C-6	44.0 a	35.3 abc	33.3 bc	30.5 ab	27.7 a
C-7	42.7 a	34.7 bc	33.5 bc	31.0 ab	26.7 a
C-8	43.3 a	34.8 bc	33.3 bc	31.8 ab	24.2 a
C-9	42.7 a	32.7 cd	33.7 bc	30.2 abc	23.8 a
C-10	42.0 a	29.5 e	34.7 abc	30.2 abc	25.5 a
C-11	43.3 a	33.0 cd	33.5 bc	29.5 bcd	25.5 a
C-12	40.5 a	34.5 bc	34.2 bc	31.5 abc	26.3 a
C-13	42.0 a	34.7 bc	32.8 bc	31.5 ab	26.3 a
C-14	44.0 a	31.0 de	36.3 ab	28.0 cd	27.2 a

<sup>1/</sup> PDA = potato-dextrose agar, CMA = corn meal agar, V-8 = V-8 juice agar, SBLEA = sugarbeet leaf extract agar, CSA = Czapek's solution agar.

<sup>2/</sup> Means of 3 samples; means of any given medium followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

A factorial analysis of the data from the overall experiment indicated that differences among isolates, media, and days (time interval from plating) were highly significant. The interactions, isolates x media and media x days, also were highly significant. The interaction, isolates x days, was not significant. The coefficient of variability for the experiment was 6.9%.

Separate analyses of variance were performed on final growth (12 days) of the isolates for each medium (Table 2). Differences in growth of the isolates on PDA or CSA were not significant. However, significant differences in growth among isolates occurred on CMA, V-8, and SBLEA.

All isolates formed typical Cercospora colonies on the test media. Differences in cultural appearance, especially in marginal pigmentation



and intensity of aerial mycelium pigmentation, were obvious on any given medium. However, with one exception, no grouping of isolates was possible based on mutual characteristics on all media. Only isolate C-2 was consistently lighter in color than all other isolates on PDA, CMA, V-8, and SBLEA.

### Discussion

Although differences in growth among isolates on CMA, V-8, and SBLEA were significant, no consistent patterns could be established. Thus, an isolate that attained maximum growth on one medium often was least vigorous on another medium. Indeed, the highly significant isolates x media interaction in the overall analysis indicated that the relative behavior of the isolates differed substantially on the test media.

The failure of the Cercospora isolates to fall into a few regimented categories or groups may indicate that C. beticola exists in nature as a multitude of physiological biotypes with relatively minute differences in nutritional requirements. Tests in pathogenic virulence on strains of beets having different degrees of resistance can only determine the importance of these cultural biotypes in a breeding program for Cercospora resistance.

### Summary

Differences in growth among 14 single-spore isolates of Cercospora beticola on potato-dextrose or Czapek's solution agars were not significant. Significant differences in growth occurred on corn meal, V-8 juice, and sugarbeet leaf extract agars. However, a significant isolates x media interaction indicated that the relative behavior of the isolates differed on the test media. Differences in cultural characteristics also were evident but, again, the relative behavior of the isolates depended on the media. Thus, no grouping of isolates was possible based on growth or mutual characteristics on all media.

### Literature Cited

1. Calpouzos, L., and G. F. Stallknecht. 1966. Phototropism by conidiophores of Cercospora beticola. Phytopathology 56:702-704.
2. Miller, P. M. 1955. V-8 juice agar as a general purpose medium for fungi and bacteria. Phytopathology 45:461-462.

# DISEASE OBSERVATIONS IN COLORADO, TEXAS, NEW MEXICO, AND UTAH

E. G. Ruppel and J. O. Gaskill

A brief survey in September, 1969, of sugarbeet fields near Rocky Ford, Colorado, Hereford, Texas, Clovis, New Mexico, and Logan, Utah, uncovered several diseases as indicated in the following table.

Diseases	Incidence of diseases at <sup>1/</sup>			
	Rocky Ford	Hereford	Clovis	Logan
Bacterial blight	M	-	-	-
Beet mosaic	L	H	H	-
Cercospora leaf spot	L	H	H	-
Curly top	L	L	-	H <sup>2/</sup>
Fusarium yellows	L	-	-	-
Phoma leaf spot	T	-	-	-
Rhizoctonia foliar blight	L	L	-	-
Rhizoctonia root or crown rot	L	L	-	-
Savoy	T	-	-	-
Yellows (beet and/or western)	M	L	H	M
Yellow vein	T	T	-	-

<sup>1/</sup> M = moderate, L = low, H = high, T = trace, - = not found.

<sup>2/</sup> Inoculated experimental field; curly top usually rare at this location.

Most striking was the rather high incidence of beet mosaic and Cercospora leaf spot in the Hereford and Clovis areas, and the ubiquitous occurrence of virus yellows in all fields visited.

AMINO ACID STUDY OF SUGARBEET SAMPLES  
FROM HEALTHY AND CERCOSPORA INFECTED PLANTS

G.W. Maag, R.J. Hecker, and J.O. Gaskill

This is a cooperative study with Professor Merle G. Payne of the Colorado State University Chemistry Department.

This 1968 experiment was designed primarily to study the difference in the free amino acids in freshly harvested disease-free sugarbeet leaves and in leaves from the same varieties of sugarbeets which had been infected with Cercospora beticola (leaf spot). We also studied the relationship of these amino acids to the phenolic compound, 3-hydroxytyramine, which according to Harrison et al. (5) is positively associated with leaf spot resistance. Impurity components of sugarbeet thin juice and yield factors were also studied in the healthy and diseased plants.

Since 1957 the chemotherapeutic effect of amino acids and amino acid analogues against fungal disease of different plants has been studied by several investigators (10). In this study we have attempted to discover the quantitative difference, if any, in the individual amino acids which exist in healthy and diseased leaves of resistant and susceptible varieties of sugarbeet. Some researchers believe that the effectiveness of phenolic compounds in disease resistance may depend upon the concentration of certain amino acids which may be present. Flood and Kirkham (3) concluded from their work on resistance of some varieties of apples to the fungus Venturia inaequalis that the effect of the phenolic compounds on the fungus was dependent upon the concentration of the amino nitrogen. Not only does the amino nitrogen concentration at the time of infection determine the development of the disease but the physiological response of the host is also a factor. For this reason we are interested also in the changes in the amino acid patterns as the disease progresses.

Materials and Methods

The materials used for this experiment were grown under irrigation at the Colorado State University Agronomy Research Center and at the Disease Farm nursery at Fort Collins, Colorado.

Four populations covering a wide range of leaf spot resistance were planted at both locations in a randomized block design with four replications. At the Agronomy Research Center each plot consisted of a 19-foot single row separated by a common competitor variety, while at the Disease Farm 12-foot two row plots were used. Planting date at the Agronomy Research Center was April 16 and at the Disease Farm, May 2, 1968. Fresh leaves were harvested at each location on six different dates during the summer. Of the four populations used for the study two were open pollinated varieties and two were inbreds. The four populations were:

1. US 201, highly leaf spot resistant (LSR), heterogeneous
2. GWI-29, leaf spot resistant (LSR), inbred
3. R & G Pioneer, leaf spot susceptible (LSS), heterogeneous
4. 52-407, leaf spot susceptible (LSS), inbred

The leaf samples were harvested at each location on the same day and as near the same time of day as possible. At each sampling we selected the youngest fully expanded leaves. One leaf was selected from each plant in the plot. The leaves were carefully stacked, tip to tip and petiole to petiole, and placed in a plastic bag with an identification tag. As soon after harvest as possible, a 7.5 gram transverse center section was cut from each sample and analyzed for 3-hydroxytyramine according to the method outlined by Harrison et al. (6). Each amino acid sample was obtained by pooling an equal amount from the midsection of the leaves from each of the four reps. These samples were prepared and analyzed according to the method outlined by Payne et al. (9). Since the amino acid analysis using the Technicon Amino Acid Analyzer is a very time consuming process the replications had to be pooled. The samples were stored frozen until analyzed.

The first leaf harvest at both locations was on July 5, prior to Cercospora inoculation at the Disease Farm on July 8. The second harvest was July 22 when the first lesions had appeared on the two susceptible varieties. The third harvest, July 31, was at the time the first cycle lesions were sporulating on the susceptible varieties. On August 14, date of the fourth harvest, second cycle lesions were present. The fifth harvest, August 23, found the second cycle lesions sporulating and at the time of the sixth (final) harvest, September 3, the infection was at its peak.

The roots from both locations were harvested on October 16. Root yield and sucrose content were determined on the roots from which phosphated thin juice was later prepared by the method developed by Brown and Serro (1), as modified by Carruthers and Oldfield (2). Recoverable sucrose was a function of root weight, sucrose, and purity, and was calculated using an equation developed by the Great Western Sugar Company. Root yield and recoverable sucrose from the disease nursery were adjusted to 19-foot rows to compare with the yields in the healthy plots. Thin juice total nitrogen was determined by the method described by Maag (7). An Orion Specific Ion electrode and meter was used for determination of the thin juice nitrate ( $\text{NO}_3^-$ ), while the procedure described by Focht et al. (4) and modified by Payne et al. (8) was used for betaine determination. We determined amino nitrogen by modification of the Moore and Stein colorimetric ninhydrin method. Hydrazine sulfate was used in place of hydrindantin as the reducing agent in the procedure. We found that hydrazine sulfate gave better reproducible results because it is less readily oxidized than hydrindantin in the procedure, if exposed to the atmosphere. A Baird-Atomic flame photometer was used for sodium and potassium determinations. All of the above quality



components were reported in mg per 100 ml of thin juice, adjusted to a refractive dry substance of 10.

Leaf spot readings were taken at the Disease Farm on August 19. The standard leaf spot scoring method from 0 to 10 was used, 0 indicating no infection and 10 indicating complete defoliation. There was a small amount of indigenous leaf spot present on the susceptible lines at the disease-free location.

### Results and Discussion

Complete statistical data is not yet available on this experiment, especially correlations with the amino acids. Consequently discussion relating to the amino acids will be from tabulated data on which only the population means have been calculated. Simple correlation coefficients between nine of the principle amino acids and harvest root weights also have been determined.

Seventeen amino acids were quantitatively determined on the fresh leaf samples taken from both Cercospora infected and healthy plants on six different harvest dates. The tabulated amount calculated as serine actually includes serine and the two amides, glutamine and asparagine. The peaks occurring on the chromatogram for these three amino acids are occluded (peaks not completely separated) at the condition of temperature and buffer pH which proved to be best for separation of the other amino acids. In fact, even at the conditions of temperature and pH when maximum separation for these amino acids could be accomplished, we still obtained considerable occlusion if the quantity of any one of the three was present even in moderate amount. Also occlusion of other amino acid peaks was then a major problem in some other areas of the chromatogram. In addition to the 17 measured amino acids there were three unknown amino acids, two of which are believed to be alpha amino-adipic acid and isovaline. The 17 amino acids measured were aspartic (Asp), threonine (Thr), serine-glutamine-asparagine (Ser-Gln-Asn), glutamic (Glu), proline (Pro), glycine (Gly), alanine (Ala), valine (Val), isoleucine (Ileu), leucine (Leu), tyrosine (Tyr), phenylalanine (Phe), lysine (Lys), histidine (His), arginine (Arg), gamma amino-butyric acid (GABA), and dihydroxyphenylalanine (Dopa). Cystine (Cys), methionine (Met), tryptophane (Try), and sometimes ornithine (Orn) occurred in trace amounts in the fresh leaf samples.

Of all the amino acids glutamic acid occurred in the largest amount in the healthy leaves of the four populations (Tables 1, 2, 3, and 4). The leaf spot susceptible variety R & G Pioneer contained the largest amount of glutamic acid when comparing the four population means. The disease resistant variety US 201 ranked lowest in glutamic acid, but not significantly below the leaf spot susceptible inbred 52-407. Aspartic acid ranked second to glutamic acid in all four populations with R & G Pioneer again showing the greatest quantity. The leaf spot resistant inbred GWI-29 showed the lowest amount of aspartic acid. The

combination of serine-glutamine-asparagine ranked third in all populations. Of these three amino acids recorded on the chromatograms as occluded peaks, glutamine appeared to be present in the greatest amount in nearly all samples. The other two amino acids present in considerable quantities in the healthy leaves were gamma aminobutyric acid (GABA) and alanine. The population means showed that healthy leaves of US 201 contained the greatest amount of both of these.

Population means for the diseased leaves (Tables 1, 2, 3, and 4) show glutamic acid as the predominate amino acid in the two heterogeneous varieties, US 201 and R & G Pioneer. R & G Pioneer had the greatest amount of glutamic acid of the four populations and the Cercospora resistant inbred, GWI-29, contained the least. All four populations had less glutamic acid in the diseased leaves than in the healthy leaves. GWI-29 showed the greatest decrease in glutamic acid when comparing the diseased and healthy leaves. The predominate amino acid in the diseased leaves of the two inbreds was GABA. The leaves of the leaf spot susceptible inbred, 52-407, contained much more GABA than the other three populations, while R & G Pioneer and GWI-29 showed almost the same amount. The diseased leaves of US 201 contained considerably less GABA than the other three populations, and a relatively small increase over what was found in the healthy leaves. The mean of the leaf spot susceptible inbred, 52-407, showed more than a three-fold increase in GABA, while R & G Pioneer and GWI-29 showed about 2.5 times as much GABA in the diseased leaves as in the healthy leaves. The third ranking amino acid in the diseased leaves was aspartic acid and in all populations it existed in almost the same quantity as was found in the healthy leaves. The serine-glutamine-asparagine combination showed a decrease in quantity in the two resistant varieties, US 201 and GWI-29, from what was found in healthy leaves, while the two susceptible varieties, R & G Pioneer and 52-407, showed an increase in the diseased leaves. Alanine showed a definite increase in the diseased leaves in all populations except US 201 which remained about the same. One amino acid which was found only in the diseased leaves and was not present in the healthy leaves was Dopa (dihydroxyphenylalanine). In one or two samples a small amount of Dopa was found in supposedly healthy leaves but we believe this was because a few indigenous leaf spot lesions were present when the leaves were harvested. In the disease nursery a much greater amount of Dopa was found in the leaves of the leaf spot susceptible varieties, R & G Pioneer and 52-407, than in the leaves of the resistant varieties. The August 19 leaf spot readings (Table 7) show that the mean for US 201 was 1.0, GWI-29 had a reading of 1.1, while R & G Pioneer and 52-407 had readings of 3.9 and 7.2 respectively.

Some of the amino acids found in lesser quantities seemed to react to disease infection almost opposite of those present in larger quantity. This was especially true of proline, valine, isoleucine, leucine, and phenylalanine. Comparing infected and noninfected plants, minor amino acids in infected plants were lower in the resistant genotypes, US 201 and GWI-29, but more was present in the two susceptible varieties,



R & G Pioneer and 52-407. Threonine stayed about the same in the resistant varieties but showed an increase in the susceptible varieties under disease conditions.

Table 5 shows the amount of the phenolic compound, 3-hydroxytyramine, in mg per 100 g of fresh leaves for the four genotypes, healthy and diseased, for the six harvest dates. Analyses of variance showed significant differences for 3-hydroxytyramine among the populations in the diseased and disease-free experiments and also in a pooled analysis of both experiments. There were also significant differences for 3-hydroxytyramine content between dates as well as significant population x date interactions for the diseased and healthy plants. Dates and population x date interactions were also significant when both experiments were pooled. Hence, neither in the healthy or diseased plants, nor when locations were pooled did all populations rank the same at all dates. GWI-29 and US 201 ranked lowest in 3-hydroxytyramine content at the time of the first harvest, especially in the leaves harvested at the Disease Farm. These leaves were younger due to a later planting date and the 3-hydroxytyramine in these resistant varieties apparently is synthesized more slowly than in the young leaves of susceptible varieties. The susceptible varieties, R & G Pioneer and 52-407, showed higher amounts of the phenolic compound at the first harvest for both locations. This sampling was taken just prior to inoculation at the Disease Farm. At the time of the other five harvests as the disease developed, the leaf spot resistant genotypes usually had a higher 3-hydroxytyramine content than susceptible genotypes, especially at the time of the third and fourth harvests. The LSR lines, when disease free, increased rapidly in 3-hydroxytyramine through August 14 (fourth sampling). LSS lines were near their highest concentration of 3-hydroxytyramine at the first sampling (July 5). Inoculated, the LSS lines increased until the climax of the epidemic, while LSR lines reached maximum contraction by the fourth and fifth samplings (August 14-23). However, the increase in LSS lines was proportionately much greater than in LSR lines. Some of this increase may have been due to injury response since 3-hydroxytyramine increases even when healthy leaves are mechanically injured, as described by Harrison *et al.* (6). It appears that any increase in 3-hydroxytyramine due to the disease injury response is not sufficient in itself to inhibit the growth of the disease, therefore it is believed that some other condition must exist in addition to the increased amount of the phenolic compound, to control the growth of the Cercospora fungus.

Table 6 shows simple correlations of 3-hydroxytyramine with leaf spot readings. Correlations were always higher between the 3-hydroxytyramine content of healthy plants and the leaf spot reading than between the 3-hydroxytyramine content of the diseased plants and the leaf spot reading. This is probably due to the disease injury, as mentioned earlier, upsetting the inherent 3-hydroxytyramine metabolism or degradation so that the 3-hydroxytyramine content then becomes a poorer indicator of disease resistance than under normal conditions. From knowledge gained by this

and previous experimental work, if one were to use 3-hydroxytyramine to evaluate genotypes for leaf spot resistance in northern Colorado one should probably do it on disease-free plants during the first two weeks in August.

Population means for the thin juice characters sodium, potassium, total nitrogen, amino nitrogen, betaine, and nitrate for all populations (Table 7) showed significantly lower quantities of each of these factors in the thin juice of plants grown at the Disease Farm than in the thin juice obtained from the healthy sugarbeets. The only exception to the above results was that the thin juice from the highly diseased genotype, 52-407, showed slightly higher potassium content than did the thin juice of 52-407 grown under disease-free conditions at the Agronomy Research Center. Some difference may be due to effect of the pathogen on the plant's ability to assimilate available soil nutrients although the resistant varieties were not highly diseased.

Population means for plot weight, percent sucrose, percent purity, recoverable sucrose, and leaf spot rating (Disease Farm only) are given in Table 7 for the healthy and diseased plants. The plot weight for the healthy plants was higher for each population than for the diseased plants with the exception of the variety GWI-29. The percent sucrose was higher in the diseased plants than the healthy plants except for the highly diseased 52-407 (leaf spot reading 7.2) which had more sucrose in the healthy plants. Percent purity was higher for the diseased plants. Recoverable sucrose was also higher for each population for the healthy plants than for the diseased plants except for GWI-29 which, as mentioned above, was also low for plot weight for healthy plants compared to the diseased plants. Its performance was low as shown by its means at both locations.

Table 8 gives the simple correlation coefficients between healthy leaf amino acids at the six leaf sampling dates and their corresponding root weights of October 16. The absence of significant correlations is disappointing. The correlation with aspartic acid is consistent but not significant, while correlation with glutamic acid is inconsistent. High positive and negative correlations with leucine have no obvious explanation at this time. From this data aspartic acid shows the most promise as an early yield indicator. With more extensive data a multivariate model describing the relation between yield and some of the amino acids might be developed. Since the amino acid investigation is new, we hope that additional experiments will give us more information which will lead to more conclusive results.

More statistical analyses, particularly correlations, remain to be made on these data. These results will be included in a comprehensive report planned for 1970.

A 1969 study is in progress which will supplement this 1968 experiment. Three of the same populations (US 201, GWI-29, and R & G Pioneer) are included in the new study. In addition, the highly LSS inbred 52-334



has been added. According to previous studies 52-334 has a very low 3-hydroxytyramine content. Correlation of the results from the two years should give sufficient information to evaluate the amino acids and their role in Cercospora leaf spot resistance.

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Table 1. US 201--Amino acids in micromoles/100g fresh leaves.

[illegible]

Table 2. GWI-29--Amino acids in micromoles/100g fresh leaves.

[illegible]

Table 3. R&G Pioneer--Amino acids in micromoles/100g fresh leaves.

[illegible]



Table 4. 52-407--Amino acids in micromoles/100g fresh leaves.

Amino Acid	Diseased or Healthy	Sampling Date						Mean
		July 5	July 22	July 31	Aug. 14	Aug. 23	Sept. 13	
Asp	D	145.16	143.96	283.56	157.92	116.36	177.00	170.66
	H	88.44	122.72	280.92	146.88	207.60	151.68	166.37
Thr	D	12.88	12.16	occ.	49.44	28.88	20.04	24.68
	H	occ.	6.24	19.52	11.16	17.96	8.40	12.62
Ser-Gln-Asn	D	136.48	59.60	178.28	179.88	140.44	116.80	135.25
	H	176.84	38.64	251.04	51.76	92.60	55.04	110.99
Glu	D	224.08	217.84	317.84	149.96	92.28	164.40	194.40
	H	185.88	200.40	427.84	170.36	241.52	189.32	235.89
Pro	D	occ.	20.20	occ.	17.04	16.88	17.36	17.87
	H	occ.	Trace	14.56	8.52	18.04	13.80	13.73
Gly	D	48.52	4.84	9.96	14.36	13.64	Trace	18.26
	H	55.32	1.72	16.16	4.36	6.80	1.80	14.36
Ala	D	59.96	23.08	44.28	109.28	151.24	occ.	77.57
	H	87.32	19.12	63.76	44.96	44.72	occ.	51.97
Val	D	18.16	7.96	occ.	occ.	occ.	occ.	13.06
	H	23.32	2.20	15.32	5.56	10.36	2.12	9.81
Ileu	D	13.80	5.88	3.44	17.96	9.24	5.12	9.24
	H	20.00	1.84	8.48	2.92	6.00	Trace	7.85
Leu	D	7.48	6.72	4.40	24.32	11.64	9.44	10.67
	H	11.28	2.60	7.28	4.76	5.60	5.56	6.18
Tyr	D	20.12	6.28	10.36	9.16	7.24	3.52	9.45
	H	27.08	2.24	12.92	3.60	6.80	2.84	9.25
Phe	D	5.92	4.20	6.00	10.76	10.04	4.72	6.94
	H	10.92	2.20	6.88	3.60	5.60	3.16	5.39
Lys	D	1.80	2.92	1.80	10.36	4.04	7.08	4.67
	H	1.32	1.76	1.20	2.40	3.20	3.56	2.24
His	D	1.48	2.16	1.92	9.56	4.40	2.16	3.61
	H	1.76	Trace	2.24	1.28	2.04	Trace	1.83
Arg	D	Trace	Trace	Trace	6.76	2.36	Trace	4.56
	H	1.68	Trace	2.72	1.24	1.72	Trace	1.84
Gaba	D	occ.	occ.	147.32	287.32	343.60	275.28	263.38
	H	121.32	59.56	63.00	100.32	55.08	102.00	83.55
Dopa	D	2.24	4.16	3.56	59.56	4.96	4.08	13.09
	H	None	Trace	Trace	3.68	Trace	Trace	3.68

Table 5. Means for 3-hydroxytyramine (mg/100g) in healthy (H) and diseased (D) leaves, four populations, six harvest dates.

Sampling Date	Population and location									
	R&G Pioneer		52-407		GWI-29		US 201		Mean	
	H	D	H	D	H	D	H	D	H	D
July 5	89.8	62.8	86.0	85.2	41.2	13.8	51.5	16.0	67.1	44.4
July 22	74.8	60.0	50.2	53.5	80.2	90.2	90.8	80.0	74.0	70.9
July 31	98.8	100.2	68.2	75.8	232.0	119.0	141.0	167.5	135.0	115.6
Aug. 14	90.8	114.2	64.0	108.8	230.2	140.5	152.0	152.5	134.2	129.0
Aug. 23	79.0	86.0	68.0	148.8	88.0	107.5	117.8	195.8	88.2	134.5
Sept. 3	73.5	135.5	61.0	129.2	219.0	113.0	125.0	171.5	119.6	137.3
Mean	84.4	93.1	66.2	100.2	148.5	97.3	113.0	130.5	103.0	105.3

Table 6. Simple correlations (r) between 3-hydroxytyramine at the six sampling dates and leaf spot rating 1968 (N-2 = 14, df for r).

Sampling Date	Correlation (r)	
	Diseased	Healthy
July 5	0.86**	0.50*
July 22	-0.56*	0.69**
July 31	-0.65**	0.75**
August 14	-0.58*	0.74**
August 23	-0.12	-0.31
September 3	-0.17	-0.63**

Table 7. Population means for leaf spot rating, yield characters and thin juice characters [Healthy (H), Diseased (D)]

Population and Location	Yield characters				Rec. suc. (kg/plot)	Thin juice characters (mg/100ml)					
	Leaf spot	Root yield (kg/plot)	Suc. (%)	Purity (%)		Na	K	Total N	Amino N	Beta-ine	NO <sub>3</sub> <sup>-</sup>
US 201											
H		8.28	13.4	91.5	.94	57.09	130.5	54.64	17.52	128.5	35.79
D	1.0	5.23	15.6	95.0	.73	9.18	71.3	16.35	7.09	89.1	1.89
GWI-29											
H		3.05	13.2	88.4	.35	76.64	104.5	63.84	17.84	147.8	43.48
D	1.1	4.62	16.9	96.4	.72	8.46	53.5	22.36	8.10	114.7	1.56
R&G Pioneer											
H		14.84	14.3	91.0	1.70	62.48	113.4	59.94	23.08	120.3	32.70
D	3.9	8.16	15.9	95.5	1.18	17.28	89.8	25.53	10.04	94.5	6.05
52-407											
H		9.79	14.2	89.7	3.84	34.79	147.0	56.05	18.47	163.9	21.91
D	7.2	5.90	12.8	90.1	.48	26.07	148.5	41.59	15.29	138.8	13.32
Mean											
H		8.99	13.78	90.15	1.71	57.75	123.8	58.62	19.23	140.1	33.47
D	3.3	5.98	15.30	94.25	.78	15.25	90.8	26.46	10.13	109.3	5.70



Table 8. Simple correlation coefficients (r) between healthy leaf amino acids and their corresponding harvest root weights\* (n-2 = 2 df for testing r).

Amino Acid	1968 Leaf Sample Harvest Dates					
	July 5	July 22	July 31	Aug. 14	Aug. 23	Sept. 3
Ser	-.96*	+.08	+.35	-.12	-.32	+.49
Asp	+.76	+.66	+.68	+.75	+.83	+.73
Glu	+.38	+.76	+.87	+.25	+.25	+.56
Ala	-.48	-.52	+.88	-.28	+.24	--
Val	-.13	--	+.15	--	--	--
Ileu	+.90	--	+.29	--	+.85	--
Leu	-.97*	--	-.51	-.63	-.97*	+.96*
Tyr	+.05	--	+.25	+.30	+.47	--
Phe	-.07	--	--	--	-.02	--

\* Significant at 0.05.

-- Amino acid curves were occluded or showed only trace amounts of amino acids.

## EFFECT OF NITROGEN FERTILIZATION ON AMINO ACID CONTENT OF SUGARBEET

G.W. Maag and R.J. Hecker

### Introduction

This experiment was designed to learn the effect of nitrogen fertility level on individual amino acids in sugarbeet. Correlations of the impurity and quality components with individual amino acids and with one another will also be studied. Experimental data concerning the response of the amino acids at different nitrogen fertility treatments may provide information on amino acid interrelationships and their effect on different genotypes at commercial nitrogen levels. Chemical-genetic studies pertaining to the potential processing quality of sugarbeets are of special interest. In numerous earlier experiments correlation studies have been made on other nitrogenous constituents such as total nitrogen, nitrate, and betaine, but few studies have been made on the amino acids in sugarbeet. In 1966 and 1967 studies were made at different nitrogen fertility levels by Payne et al. (1) on the relationship of certain amino acids to other impurity and quality components. They found that the measurable amino acids in thin juice increased with increasing nitrogen fertilization. The differences caused by nitrogen fertilization were greater than the differences attributable to genotype. It appeared that little could be done by genotype to overcome the detrimental quality effects of excess nitrogen. As nitrogen fertilization increased, the proportion of total thin juice nitrogen accounted for by the amino acids, amino nitrogen and betaine declined while that of nitrate nitrogen increased. This 1968 experiment was designed as an extended study of these two previous years using a wider range of nitrogen fertility levels.

### Materials and Methods

In 1968 the populations used included the open pollinated variety GW 359-52R which had been used in 1966 and 1967 and will be referred to as population 1. In addition two  $F_1$  hybrids were used, 52-305CMS x 54-346,  $F_1$  (population 2) and 52-407CMS x GWI-81,  $F_1$  (population 3). Population 2 had shown high thin juice purity in an earlier study and population 3 had shown low thin juice purity. The planting date was April 15, and the experiment was grown under irrigation at the Colorado State University Agronomy Research Center. A split plot design was used with six replications grown in single row sub-plots separated by a common competitor row. Two extra competitor rows were used between the nitrogen fertility treatments (main plots) of 0, 125, 250, 375, and 500 lbs. nitrogen per acre (all preplant, broadcast, and harrowed).

Leaf samples (youngest fully expanded leaves) were harvested October 9, and roots were harvested October 10. Samples for amino acid analyses were prepared from fresh leaves, roots, and thin juice according to the method described by Payne et al. (1). Root yield (kg/plot), sucrose (%),

thin juice purity (%) and recoverable sucrose (kg/plot) were determined. Thin juice was prepared by the Brown and Serro method as modified by Carruthers and Oldfield. The thin juice characters of total nitrogen, nitrate, amino nitrogen, betaine, sodium, and potassium were determined and reported in mg per 100 ml adjusted to a refractive dry substance (RDS) of 10. Thin juice amino acids were reported in micromoles per 100 ml (RDS 10) and the leaf and root amino acids were recorded in micromoles per 100 grams of leaf and root tissue.

### Results and Discussion

Complete analyses of the leaf amino acids have not yet been completed. The thin juice and fresh root amino acids have been determined and population and nitrogen treatment means have been calculated. All root quality components and all thin juice characters have also been determined with population and nitrogen treatment means but no correlation analyses have been made because of the incomplete leaf amino acid analyses.

Eighteen measurable amino acids were found in thin juice, including aspartic (Asp), threonine (Thr), serine-glutamine-asparagine (Ser-Gln-Asn), glutamic (Glu), proline (Pro), glycine (Gly), alanine (Ala), valine (Val), methionine (Met), isoleucine (Ileu), leucine (Leu), tyrosine (Tyr), phenylalanine (Phe), gamma aminobutyric acid (GABA), lysine (Lys), histidine (His), tryptophan (Try), and arginine (Arg). The serine-glutamine-asparagine peaks were occluded (not completely separate peaks) on the chromatograms and, therefore, could not be calculated as individual amino acids. In nearly all samples the glutamine portion of the three occluded peaks was largest. Three unidentified amino acids were also present in the thin juice. Two of these are believed to be alpha amino-adipic acid and isovaline, but as yet we have been unable to make positive identification of these.

In the fresh root samples we found the same amino acids as in the thin juice with one exception. Dihydroxyphenylalanine (Dopa) was found in the fresh roots but was not present in thin juice. Apparently it is converted to something else in the thin juice preparation. Dopa is closely related to the phenolic compound, 3-hydroxytyramine, which is found in sugarbeet leaves. In 3-hydroxytyramine, which is often called dopamine, the carboxyl group of the amino acid is replaced by the amine group. Both dopa and dopamine can be formed, usually by enzymatic action, from phenylalanine and tyrosine.

Although the amino acid analyses have not been completed on the leaf samples we can report what amino acids are found in the leaves. Most of the amino acids present in thin juice and fresh root samples are also present in fresh leaves. Cystine is one exception. Varying amounts of cystine are found in the leaves while none is present in the root and thin juice samples. Only trace amounts of methionine and arginine are usually present in the leaves. Usually a larger amount of



GABA is present in the leaves than in the root and thin juice samples. GABA often shows a marked increase, especially in leaf spot susceptible genotypes, if Cercospora lesions are present. Dopa was not found in leaf tissue, except when Cercospora infection was present, even though a large amount of the phenolic compound, dopamine, may be present in the leaves.

Since correlation studies have not been made on the amino acids we will discuss only the population and nitrogen treatment means. The open pollinated genotype, GW 359-52R, (population 1) and the F<sub>1</sub> hybrid, 52-305CMS x 54-346, F<sub>1</sub>, (population 2) showed normal increase in the quantity of some amino acids as the nitrogen fertility level increased (Table 1) but there were exceptions. Aspartic acid in population 1 showed a decrease for the 250 lb. nitrogen treatment and showed little increase in the 375 lb. treatment over the 125 lb. nitrogen level. A similar response was shown in the serine-glutamine-asparagine area. These three occluded amino acids actually showed a decrease for both the 250 and 375 lb. treatment compared to the 125 lb. treatment, but showed an increase for the 500 lb. nitrogen treatment. Population 2 showed, without exception, less amino acids at the 125 lb. nitrogen level than at the 0 lb. level. Also an expected increase was not shown for several amino acids when the nitrogen fertility levels were 250 and 375 lb. nitrogen. The three populations showed little variation in thin juice amino acids between nitrogen treatments for methionine, lysine, histidine, tryptophan, and arginine, except population 1 did show an increase in methionine in the 125 lb. level over the 0 lb. treatment and another increase going from 250 lbs. to the 375 lb. level but no additional increase at the 500 lb. level. In populations 2 and 3 phenylalanine was almost the same quantitatively for each nitrogen level. The F<sub>1</sub> hybrid, 52-407CMS x GWI-81, F<sub>1</sub>, (population 3) showed greater quantities of all the principle thin juice amino acids at the 0 nitrogen level than at the 125 lb. level and, in some cases, even more than was present at the 250 lb. level. There was more glutamic acid present in the thin juice at the 0, 250, and 375 level than at the 500 lb. level, with the 250 lb. level showing the greatest amount. This population seemed to respond differently to the increase in available nitrogen than did populations 1 and 2. The thin juice population means for all 5 nitrogen treatments (Table 1) showed that population 3 contained more aspartic, serine-glutamine-asparagine, and glutamic acids than populations 1 and 2. Population 1 showed a higher content of isoleucine, leucine, tyrosine, and GABA than populations 2 or 3. Usually means for population 3 were slightly higher than for population 2 which we could expect from a previous experiment which showed population 2 to have higher thin juice purity than population 3. Nitrogen treatment means for the three populations (Table 1) show that the amino acid content of the thin juice from the 125 lb. nitrogen fertility level was lower than at the 0 nitrogen level except for methionine. This was due to the two F<sub>1</sub> hybrids (population 2 and 3). Population 1, on the other hand, had more of each amino acid at the 125 lb. nitrogen than at the 0 lb., except for Gly, Phe and Try which were present in relatively small quantities.



Population means for fresh root amino acids (Table 2) showed many of the same proportionate differences as were present in the thin juice amino acids. This is to be expected since the free amino acids are not removed in thin juice preparation. There was a greater proportionate amount of the serine-glutamine-asparagine combination in the fresh roots compared to the aspartic and glutamic acid content than was present in the thin juice. This is probably due to the conversion of the amides, glutamine and asparagine, to glutamic and aspartic acids during the thin juice preparation. The threonine content of population 1 at the 500 lb. nitrogen level was extremely high in root samples. The  $F_1$  hybrid, population 3, showed a large amount of both the serine-glutamine-asparagine combination and glutamic acid at the 250 lb. nitrogen fertility level in the fresh roots. The thin juice of population 3 also showed a large amount of glutamic acid at the 250 lb. level. The root amino acid means for the five nitrogen treatments (Table 2) showed almost the same relationships between the three populations as was shown in the thin juice population means. Population 3 ranks the highest in the principle amino acids with population 2 ranking the lowest. Population 1 again contains the largest amount of such amino acids as alanine, isoleucine, leucine, etc. as was true in the thin juice means. The root amino acids nitrogen treatment means for the three populations (Table 2) showed a greater quantity of the combination of serine-glutamine-asparagine compared to the amount of aspartic and glutamic acids than was found in the thin juice. Some of the asparagine and glutamine, as mentioned above, was converted to aspartic and glutamic acids during thin juice preparation. Difficulty was encountered with quantitative determination of a few amino acids such as proline in the thin juice and fresh root samples. The proline peak, for example, appears on the chromatogram shortly after glutamic acid. When glutamic acid is present in large quantities it is often difficult to obtain completely separate peaks on the chromatogram. Since proline is much the smaller of the two peaks, it is the one that is most affected. Threonine was also often occluded because of its proximity on the chromatogram to the much larger serine-glutamine-asparagine peaks.

The population means for the five nitrogen treatments for the yield and thin juice characters are given in Table 3. All three populations showed many of the same proportionate differences between nitrogen treatments in the thin juice characters as were present in the thin juice amino acids. Population 1 shows less total N, amino N, betaine,  $\text{NO}_3^-$ , and Na at the 250 lb. nitrogen level than at the 125 lb. level. The amino N decreased again at the 375 lb. level. In population 1, however, K gained with each increase in nitrogen. In population 2 the total N, betaine, Na, and K decreased at the 125 lb. level from what was present at the 0 lb. N level; the amino N, betaine, and Na showed a decrease in the 375 lb. treatment from the 250 lb. treatment. Population 3 was even more erratic in its response to N treatments. Total N was least at 125 lbs. of nitrogen. Total N, amino N, betaine,  $\text{NO}_3^-$ , Na, and K all declined in the 375 lb. level from what was found in the 250 lb. treatment. Total N, amino N,  $\text{NO}_3^-$ , and Na showed an additional decline at the 500 lb. level.

Population 3 had also shown a definite decline in the amount of several thin juice amino acids at the 500 lb. treatment, including glutamic acid. When we compare the three population means, pooling all nitrogen treatments, population 3 shows the largest quantity of each thin juice factor, and population 2 shows the lowest quantity of each.

Table 3 also contains yield character means for each population and treatment. For population 1 the two highest plot weights were produced at the 125 lb. and 0 lb. N fertility levels respectively, but the 0 lb. level gave the highest recoverable sucrose because of the higher percent sucrose and purity factors. Population 2 had the highest plot weight at the 500 lb. nitrogen level, however the 375 lb. treatment gave almost the same amount of recoverable sucrose again because of purity factors. Population 3 produced the highest amount of recoverable sucrose at the 125 lb. nitrogen level and also showed the highest plot weight at that level although the 500 lb. N treatment showed nearly the same plot weight. Again because of lower purity at the 500 lb. treatment the recoverable sucrose was less. When we look at the population means for all nitrogen treatments we find that population 3 gave the highest plot weight but population 1 produced the greatest amount of recoverable sucrose with population 3 a close second.

Population differences in this study were quite evident in the amino acids, thin juice quality components, and yield factors. All populations showed rather unusual response to different nitrogen fertility levels with the amino acids and thin juice characters showing almost the same response.

#### Literature Cited

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Relation of certain amino acids to other impurity and quality components of sugarbeet. Accepted for publication by J. Am. Soc. Sugar Beet Technol.

Table 1. Thin juice amino acids (micromoles/100 ml thin juice).

Amino Acid	Pop. No.	Nitrogen Treatment (lbs/A)					Pop. Mean
		0	125	250	375	500	
Asp	1	60.04	88.67	70.14	89.97	118.88	82.20
	2	83.80	52.30	85.69	69.37	123.30	82.89
	3	96.97	76.74	103.28	92.79	81.71	90.76
	N MEAN	74.71	66.44	86.37	84.04	107.96	
Thr	1	occ.*	occ.	occ.	occ.	occ.	occ.
	2	8.88	occ.	occ.	occ.	occ.	8.88
	3	occ.	occ.	occ.	occ.	occ.	occ.
	N MEAN	8.88	occ.	occ.	occ.	occ.	
Ser-Gln-Asn	1	89.30	130.06	95.22	80.87	178.53	116.76
	2	115.13	73.48	104.12	99.15	196.83	116.84
	3	122.95	99.83	166.47	185.51	86.07	137.18
	N MEAN	110.29	101.28	120.82	129.04	164.23	
Glu	1	181.61	203.48	196.34	244.50	290.58	224.23
	2	222.38	150.42	195.35	222.49	291.56	216.44
	3	221.85	202.20	305.61	272.64	211.71	244.35
	N MEAN	208.62	184.38	234.55	245.01	267.73	
Pro	1	13.99	occ.	15.52	occ.	occ.	14.76
	2	occ.	occ.	occ.	occ.	occ.	occ.
	3	occ.	occ.	occ.	occ.	occ.	occ.
	N MEAN	13.99	occ.	15.52	occ.	occ.	
Gly	1	5.63	5.32	6.48	8.52	9.52	7.09
	2	5.66	4.35	6.20	5.15	10.26	6.32
	3	6.68	4.81	6.63	9.09	7.08	6.92
	N MEAN	5.99	4.83	6.43	7.59	9.09	
Ala	1	19.57	21.36	26.68	21.25	34.34	25.36
	2	19.74	16.79	24.65	21.59	47.21	25.89
	3	28.31	18.52	22.96	30.48	24.77	25.50
	N MEAN	22.54	19.08	24.76	25.43	35.37	
Val	1	9.26	11.47	12.39	16.01	14.56	12.54
	2	12.89	9.54	12.56	11.12	15.44	12.31
	3	15.46	11.72	9.62	10.79	10.94	11.57
	N MEAN	12.36	10.86	11.52	12.64	13.64	
Met	1	2.57	5.09	4.95	7.90	7.08	5.46
	2	4.95	4.70	6.52	2.20	5.35	4.46
	3	5.01	3.44	4.55	5.49	5.96	4.91
	N MEAN	4.06	4.35	5.05	5.01	6.09	

Table 1. Thin juice amino acids (micromoles/100 ml thin juice), cont'd.

Amino Acid	Pop. No.	Nitrogen Treatment (lbs/A)					Pop. Mean
		0	125	250	375	500	
Ileu	1	17.27	22.67	20.69	27.59	31.81	24.00
	2	18.98	12.44	18.96	17.63	28.12	19.23
	3	23.49	17.40	24.49	25.92	21.64	22.77
	N MEAN	19.91	17.51	20.25	23.71	27.19	
Leu	1	18.53	22.74	22.10	29.51	33.32	25.24
	2	20.42	13.86	20.59	19.03	28.18	20.42
	3	25.38	18.52	22.63	23.77	20.86	22.36
	N MEAN	21.44	18.36	21.77	24.10	27.45	
Tyr	1	11.13	16.30	18.45	41.08	39.95	24.84
	2	15.59	8.97	15.42	10.36	29.60	16.00
	3	22.87	14.11	17.21	22.99	21.19	19.76
	N MEAN	16.58	13.06	17.03	23.91	30.25	
Phe	1	2.53	1.93	2.80	4.18	2.83	2.97
	2	2.83	2.41	2.38	2.24	3.84	2.79
	3	2.92	2.82	2.42	2.21	2.67	2.62
	N MEAN	2.76	2.39	2.52	3.06	3.20	
GABA	1	31.72	34.46	32.24	39.64	42.31	36.08
	2	27.06	24.37	30.55	27.77	38.72	29.76
	3	36.33	30.93	27.44	30.32	29.96	31.00
	N MEAN	31.70	29.86	30.08	32.86	37.00	
Lys	1	4.67	4.83	4.55	4.99	4.78	4.77
	2	5.40	4.11	5.33	4.90	5.95	5.14
	3	4.80	4.94	4.58	4.31	4.57	4.63
	N MEAN	4.96	4.61	4.82	4.73	5.10	
His	1	2.28	2.40	2.42	3.15	2.51	2.55
	2	2.58	1.98	2.50	2.20	3.15	2.48
	3	2.35	2.46	1.97	2.26	2.26	2.25
	N MEAN	2.40	2.27	2.30	2.54	2.64	
Try	1	4.01	3.57	4.22	5.68	3.92	4.24
	2	3.46	3.44	3.96	3.13	3.75	3.51
	3	3.97	3.14	3.19	3.64	3.58	3.52
	N MEAN	3.82	3.36	3.77	4.04	3.79	
Arg	1	3.03	3.34	3.17	3.80	3.24	3.31
	2	3.45	2.31	3.13	3.02	4.24	3.19
	3	3.52	3.34	2.76	3.11	3.58	3.23
	N MEAN	3.32	2.95	3.02	3.31	3.66	

\* = occluded peaks



Table 2. Fresh root amino acids (micromoles/100 grams fresh root).

Amino Acid	Pop. No.	Nitrogen Treatment (lbs/A)					Pop. Mean
		0	125	250	375	500	
Asp	1	154.04	175.03	160.21	156.31	189.82	167.08
	2	181.61	144.16	120.49	131.57	233.37	162.24
	3	194.97	154.80	241.17	165.25	171.23	185.48
	N MEAN	176.87	158.00	174.00	151.04	198.14	
Thr	1	occ.*	12.88	occ.	18.62	144.60	48.68
	2	20.45	15.04	7.98	8.48	occ.	14.42
	3	21.38	26.72	occ.	33.48	23.10	25.12
	N MEAN	20.76	20.34	7.98	17.54	63.60	
Ser-Gln-Asn	1	229.17	307.52	292.67	333.17	363.80	305.27
	2	243.30	186.15	154.33	247.25	377.95	241.79
	3	320.39	210.68	523.31	366.99	387.75	361.82
	N MEAN	264.28	234.78	323.44	315.80	376.50	
Glu	1	296.89	337.01	342.43	353.43	383.25	342.61
	2	355.18	271.89	243.83	299.37	392.33	308.52
	3	311.90	302.25	471.24	345.42	381.25	362.41
	N MEAN	314.66	303.72	352.50	332.76	385.61	
Pro	1	occ.	occ.	occ.	occ.	occ.	occ.
	2	occ.	occ.	occ.	14.60	occ.	14.60
	3	occ.	occ.	occ.	occ.	23.92	23.92
	N MEAN	occ.	occ.	occ.	14.60	23.92	
Gly	1	4.99	5.07	7.28	11.40	7.36	7.02
	2	6.69	4.51	14.76	4.85	10.75	8.19
	3	9.71	4.80	5.20	6.70	6.28	6.54
	N MEAN	6.99	4.82	8.37	7.65	8.13	
Ala	1	31.46	31.96	36.69	64.90	38.53	40.71
	2	27.47	26.59	23.14	30.73	55.87	32.76
	3	38.43	28.74	31.84	35.95	35.58	34.11
	N MEAN	32.45	29.10	30.56	43.86	43.32	
Val	1	17.93	16.41	16.49	21.77	15.80	17.68
	2	17.25	14.13	13.81	14.32	20.67	16.04
	3	15.65	16.88	12.99	13.22	15.71	14.89
	N MEAN	16.94	15.81	14.43	16.44	17.39	
Met	1	6.38	5.77	6.56	8.42	7.37	7.06
	2	5.67	10.68	5.22	None	7.57	6.84
	3	8.35	4.84	5.89	5.73	7.62	6.61
	N MEAN	6.85	6.28	5.98	7.08	7.52	

\* Occluded peaks

Table 2. Fresh root amino acids (micromoles/100 grams fresh root), cont'd.

Amino Acid	Pop. No.	Nitrogen treatment (lbs/A)					Pop. Mean
		0	125	250	375	500	
Ileu	1	25.38	30.59	27.46	36.65	39.25	31.86
	2	26.99	18.19	22.45	22.29	37.35	25.45
	3	32.08	21.94	33.40	33.47	29.26	30.03
	N MEAN	28.15	23.57	27.77	30.80	35.28	
Leu	1	28.28	32.53	30.93	40.34	42.17	34.85
	2	28.39	20.40	26.29	23.66	38.99	27.55
	3	37.91	23.99	29.85	32.05	29.09	30.58
	N MEAN	31.53	25.64	29.02	32.02	36.75	
Dopa	1	11.68	11.83	12.85	14.93	15.63	13.66
	2	15.88	19.88	10.92	8.28	10.55	12.19
	3	5.72	9.40	8.46	11.77	10.31	9.72
	N MEAN	12.29	11.92	10.42	12.52	12.06	
Tyr	1	25.33	35.85	36.05	80.07	82.19	48.69
	2	30.98	22.56	26.88	17.13	57.35	31.28
	3	55.99	29.51	37.37	49.06	54.52	44.99
	N MEAN	36.68	29.72	33.44	44.56	64.23	
Phe	1	3.79	3.36	4.72	3.62	3.85	3.79
	2	3.46	5.12	4.64	3.46	4.70	4.14
	3	4.29	3.84	2.77	3.50	5.24	3.98
	N MEAN	3.82	3.96	3.83	3.54	4.60	
GABA	1	48.64	44.92	43.73	57.45	47.11	48.66
	2	36.29	34.42	35.40	36.93	50.46	38.47
	3	49.59	37.36	37.07	35.56	39.67	40.00
	N MEAN	45.34	38.54	38.63	43.77	45.47	
Lys	1	9.43	9.07	7.75	8.37	7.65	8.45
	2	9.83	8.56	9.88	8.34	9.63	9.25
	3	8.65	8.34	7.35	6.93	7.75	7.77
	N MEAN	9.34	8.66	8.32	7.88	8.34	
His	1	4.53	4.56	4.39	5.61	4.19	4.66
	2	4.36	4.05	4.41	3.97	5.29	4.43
	3	5.04	4.38	3.47	3.93	3.98	4.12
	N MEAN	4.62	4.32	4.09	4.53	4.52	
Try	1	Trace	5.26	6.70	7.65	5.76	6.53
	2	5.44	5.80	5.08	5.02	6.12	5.51
	3	8.16	5.76	Trace	4.76	3.86	5.62
	N MEAN	7.25	5.52	6.16	6.27	5.32	
Arg	1	6.10	6.55	6.19	7.95	5.63	6.48
	2	7.03	5.43	6.26	5.49	7.23	6.32
	3	6.80	6.06	5.04	6.38	7.87	6.30
	N MEAN	6.63	6.04	5.88	6.62	6.72	

Table 3. Thin juice and yield characters.

Pop. No.		N lbs/A	Weight (kg/plot)	Sucrose (%)	Purity (%)	Rec. Suc. (kg/plot)	Total N	Amino N	Beta-ine	NO <sub>3</sub> <sup>-</sup>	Na	K
Mg/100 ml thin juice												
1		0	18.83	16.5	95.2	2.77	43.4	11.2	128.9	6.2	26.4	69.3
		125	19.36	15.9	94.2	2.73	57.4	17.7	132.7	13.2	29.6	81.8
		250	17.00	16.1	94.0	2.37	50.0	15.5	131.0	11.4	26.6	82.2
		375	17.74	15.4	92.2	2.24	59.8	12.8	143.5	13.6	32.5	83.2
		500	18.82	14.3	90.7	2.18	76.6	28.8	157.3	17.9	41.7	102.4
Pop. Means			18.35	15.6	93.3	2.46	57.5	17.2	138.7	12.5	31.4	83.8
2		0	15.80	15.6	93.7	2.13	47.6	10.6	140.5	7.1	24.8	76.2
		125	15.36	16.4	95.6	2.27	36.8	10.7	117.3	9.7	18.8	67.1
		250	16.65	15.8	93.9	2.30	48.0	16.9	139.3	11.0	29.3	79.0
		375	18.60	15.8	93.5	2.56	53.6	13.3	131.0	12.4	28.0	83.7
		500	21.91	14.4	91.0	2.55	75.4	29.3	162.8	17.0	39.2	106.7
Pop. Means			17.67	15.6	93.5	2.36	52.3	16.2	138.2	11.4	28.0	82.6
3		0	17.72	15.4	92.9	2.34	60.0	15.3	142.5	12.6	39.5	89.1
		125	20.73	15.6	94.4	2.80	49.1	13.6	144.7	12.9	25.6	80.4
		250	19.32	14.6	91.7	2.33	74.2	26.9	144.8	16.6	39.0	102.2
		375	17.65	15.0	92.3	2.61	71.7	24.9	141.3	14.6	36.2	95.5
		500	20.58	15.4	92.6	2.56	65.9	18.4	150.8	13.3	30.8	95.8
Pop. Means			19.20	15.2	92.8	2.45	64.2	19.8	144.8	14.0	34.3	92.6
N Treat. Means		0	17.45	15.8	93.9	2.41	50.4	12.4	137.3	8.6	30.3	78.2
		125	18.48	16.0	94.8	2.60	47.8	14.0	131.6	11.9	24.6	76.5
		250	17.66	15.5	93.2	2.33	57.4	19.8	138.4	13.0	31.6	87.8
		375	18.00	15.4	92.7	2.33	61.7	17.0	138.6	13.5	32.2	87.4
		500	20.44	14.7	91.4	2.43	72.6	25.5	157.0	16.1	37.3	101.6

## HETEROSIS IN SUGARBEET AS AFFECTED BY NITROGEN

R.J. Hecker and G.W. Maag

We are in the era of hybrids in sugarbeet, but little is known of the effect of nitrogen fertility on the magnitude and direction of heterosis. Also the possibility of capitalizing on heterosis for lesser quantities of thin juice impurities has never been reported. The purpose of this experiment was to determine the effect of different nitrogen environments on the magnitude and direction of heterosis for the yield characters and impurity components and to check for the presence of heterosis for lesser quantities of thin juice impurities.

### Materials and Methods

A half diallel (5 inbred parents and 10  $F_1$ 's) was planted in a split plot design at Ft. Collins in 1968. Main plots were nitrogen treatments (0, 80, and 180 lbs. actual N per acre; 80 lbs. was considered optimum after soil tests showed relatively high residual nitrogen) and sub-plots were the 15 lines [actually one parent, 52-407, was included both as a male fertile and cytoplasmic male sterile (CMS), making 16 entries in the test]. 20-foot single row plots were replicated 15 times. A moderately low vigor common competitor was planted between plots. All nitrogen was applied preplant and was incorporated into the top 2 inches of soil. The following yield characters were determined: root yield (kg/plot), sucrose (%), and recoverable sugar (kg/plot). The following thin juice characters were also measured: purity (%), total nitrogen, betaine, nitrate, amino nitrogen, sodium, potassium, calcium, magnesium, and chloride. The individual impurities were measured in mg per 100 ml of thin juice, equated to an RDS of 10. The thin juice was prepared by the Brown and Serro method as modified by Carruthers and Oldfield.

The data were not treated in a diallel analysis, although this may be done later. An analysis of  $F_1$  means was accompanied by analysis of the relative deviation of the  $F_1$ 's from their respective best parents and midparents.

### Results

The magnitude and direction of heterosis for the 13 characters and the effect of nitrogen on heterosis was determined for individual  $F_1$ 's within nitrogen treatments by transforming the hybrid values to the percent the  $F_1$  was of the best parent (Table 1). This removed the effect of absolute form and put all values in a form relative to their high parent, permitting a comparison of heterosis magnitude and direction among the hybrids. Differences between hybrids per se (Table 2) and significance of hybrid by nitrogen interactions were of secondary interest.



Table 1. F<sub>1</sub> hybrid values expressed as percent of best parent.

F <sub>1</sub> and N level	Lbs. N	Root wt.	Recov. sugar	Pur- ity	N <sub>2</sub>	Beta- ine	NO <sub>3</sub> <sup>-</sup>	Amino N	Na	K	Ca	Mg	Cl
2. 1 x 3	0	215	213	97	100	109	98	116	213	111	97	104	122
	80	203	201	97	100	129	108	124	192	124	102	118	145
	180	217	221	95	99	117	106	119	194	135	118	114	148
4. 5 x 14	0			96	100	120	103	112	149	107	102	146	143
	80			96	99	134	121	135	163	119	107	113	140
	180			96	100	124	112	116	170	126	102	129	114
6. 14 x 3	0	212	215	100	100	118	100	112	119	96	106	112	99
	80	207	210	101	99	128	115	113	112	96	100	94	133
	180	224	245	98	100	122	113	131	144	110	99	107	94
7. 14 x 16	0	206	209	99	99	136	136	233	134	113	120	114	117
	80	183	193	101	100	136	125	198	117	103	111	112	137
	180	207	209	99	100	144	126	154	119	123	116	125	113
8. 5 x 3	0	221	209	94	100	123	104	189	186	110	101	128	127
	80	233	228	97	100	120	115	172	145	112	108	122	127
	180	237	231	95	100	127	117	305	189	115	99	114	113
10. 5 x 9	0	214	227	94	99	158	117	257	248	133	106	136	222
	80	220	230	94	100	112	104	265	176	124	109	143	151
	180	215	217	92	99	129	113	476	240	125	111	131	149
11. 16 x 3	0	184	184	98	99	116	108	158	132	104	132	112	107
	80	190	187	101	98	113	107	169	125	101	99	103	127
	180	243	252	100	100	118	113	343	134	106	104	132	115
12. 5 x 16	0	186	191	95	100	128	128	144	165	111	97	120	137
	80	197	206	96	100	127	117	175	152	106	103	111	143
	180	195	200	97	100	143	126	229	157	125	113	140	132
13. 14 x 9	0	220	244	102	100	153	123	273	121	110	102	107	127
	80	194	225	104	100	125	113	216	102	115	102	110	112
	180	207	221	102	100	129	107	381	120	117	113	107	156
15. 16 x 9	0	123	127	100	99	155	120	168	130	120	114	180	127
	80	154	157	98	99	118	110	131	145	121	114	131	166
	180	142	151	102	99	127	117	241	116	127	123	121	159

Table 2. Population means and tests of differences<sup>1/</sup> between hybrids and parents.

Population	Root weight (kg/plot)	Recov. sugar (kg/plot)	Sucrose %	Thin juice purity %
1. 52-407CMS	7.473	1.127	17.3	93.9
2. 1 x 3	15.041++	2.275++	17.2o-	94.6oo
3. 54-346	3.441	0.550	17.6	94.5
4. 5 x 14			18.5-+	95.4oo
5. 52-305CMS	6.570	1.128	19.3	95.1
6. 14 x 3	14.115++	2.281++	17.9oo	95.4o+
7. 14 x 16	15.373++	2.503++	17.9o+	96.1+o
8. 5 x 3	14.522++	2.408++	18.3-+	95.6o+
9. 52-407	8.390	1.193	16.7	93.3
10. 5 x 9	18.050++	2.848++	17.9-+	94.6o+
11. 16 x 3	14.931++	2.380++	17.7oo	95.6o+
12. 5 x 16	14.803++	2.537++	18.5-+	96.6+o
13. 14 x 9	17.293++	2.786++	18.1++	95.0o+
14. 52-430	6.726	1.045	17.6	94.9
15. 16 x 9	11.776++	1.848++	17.5o+	95.3o+
16. 52-307	7.513	1.198	17.4	96.3

<sup>1/</sup> o =  $F_1$  is not significantly (0.05) different than the parent (♀ first, ♂ second).

- =  $F_1$  is significantly (0.05) worse than the parent (♀ first, ♂ second).

+ =  $F_1$  is significantly (0.05) better than the parent (♀ first, ♂ second).

i.e., -+ =  $F_1$  was significantly (0.05) worse than female parent and significantly better than male parent.

Table 2. Population means and tests of differences<sup>1/</sup> between hybrids and parents, cont'd.

Pop.	Thin juice impurities (mg/100 ml)								
	N <sub>2</sub>	Betaine	NO <sub>3</sub> <sup>-</sup>	Amino N	Na	K	Ca	Mg	Cl
1.	23.6	116.2	2.75	6.84	21.5	78.6	.845	.0534	2.38
2.	20.5+o	103.4+o	4.32--	5.93oo	29.3--	63.9+-	.782o+	.0468oo	1.96+o
3.	18.2	107.5	1.29	5.45	23.5	56.3	1.164	.0560	1.92
4.	22.2+o	117.5+o	2.82--	6.01+o	17.7--	61.0oo	.676oo	.0439oo	1.18oo
5.	28.3	147.3	1.45	8.20	12.9	58.3	.738	.0395	0.99
6.	19.1oo	101.3oo	2.52o-	5.43oo	22.4oo	49.8++	.726o+	.0432++	1.27o+
7.	19.1o-	103.7o-	2.13oo	5.38o-	23.3oo	51.9+o	.719oo	.0442+o	1.40oo
8.	20.7+o	114.0+o	2.21oo	5.35+o	19.3--	52.8+o	.697o+	.0410o+	1.13o+
9.	24.9	118.5	3.75	7.22	26.1	82.9	.811	.0488	2.38
10.	26.3oo	127.3+-	3.49-o	7.54o-	23.9-o	69.3--	.741oo	.0455oo	1.56--
11.	16.2oo	91.3o+	1.80oo	4.64oo	23.1oo	47.0o+	.710o+	.0428o+	1.41o+
12.	19.8+-	106.3+-	1.35oo	5.48+-	17.9--	51.9+o	.646oo	.0398oo	1.15--
13.	23.3-o	111.6oo	3.90-o	6.13o+	23.2oo	65.1--	.723oo	.0436+o	1.57o+
14.	19.6	109.5	1.70	5.67	22.8	58.0	.742	.0581	1.46
15.	17.8o+	94.7o+	1.63o+	4.85o+	26.0oo	57.0--	.736oo	.0538oo	1.91--
16.	15.6	87.7	1.18	4.18	23.7	48.1	.684	.0441	1.59

<sup>1/</sup> o = F<sub>1</sub> is not significantly (0.05) different than the parent (♀ first, ♂ second).

- = F<sub>1</sub> is significantly (0.05) worse than the parent (♀ first, ♂ second).

+ = F<sub>1</sub> is significantly (0.05) better than the parent (♀ first, ♂ second).

i.e., -- = F<sub>1</sub> was significantly (0.05) worse than female parent and significantly better than male parent.

One hybrid (entry 4) was excluded from the analyses for root yield and recoverable sugar because of its poor stand, particularly at the high nitrogen level, but it was included in the analyses for the other characters.

Root yield: All hybrids exceeded significantly the yield of their best parent (high parent heterosis) at all nitrogen levels. This is the case in nearly all  $F_1$ 's of highly inbred parents since inbreeding causes considerable depression in vigor and plant size. Increased nitrogen caused increased  $F_1$  yield per se and a tendency for increased heterosis, particularly for the lower yielding hybrids, although the effect on heterosis was not significant. Differences between  $F_1$ 's as percent of best parent, were significant (specific combining ability) but the  $F_1 \times N$  interaction was not significant. Since the magnitude of heterosis was not significantly changed by nitrogen fertilization, testing for specific combining ability should be equally accurate at low, medium, or high nitrogen fertilization.

Recoverable sugar: This character is primarily a function of root yield. The expression of heterosis was about the same as for root yield. Nitrogen did not significantly affect the magnitude of heterosis and there was no  $F_1 \times N$  interaction. Testing of single crosses should be possible at any nitrogen level within reasonable limits.

Sucrose: Heterosis for sucrose is usually small and infrequent. In this study the hybrids were, on the average, slightly above their midparents (101.4% of the midparents). Hybrid 13 was the only one showing best parent heterosis at all nitrogen levels, 102.7% of the best parent. Magnitude of heterosis was not affected by nitrogen level and there was no  $F_1 \times N$  interaction. There were significant differences among  $F_1$ 's (for percent of best parent), which in effect measured differences in degree of specific combining ability. One should be able to compare single crosses for sucrose equally well at any reasonable nitrogen fertility level.

Thin juice apparent purity: There were significant mean differences due to  $F_1$ 's and N levels but no  $F_1 \times N$  interaction. However, there were no differences in degree of heterosis due to  $F_1$ 's or N levels and no interaction. So in this study neither parental genotype nor nitrogen environment affected heterosis, as percent of the high parent. However, due to the small sample of  $F_1$ 's (10), one should not infer that there would be no specific combining ability differences for purity. Testing for purity heterosis could be done at any reasonable nitrogen level.

Total nitrogen (N): Heterosis for all thin juice characters was considered desirable when the quantity of the impurity was low.

Hybrids tended to have less nitrogen in their thin juice than the average of their parents; midparents were 104% of the  $F_1$ 's but in no case did the hybrid have significantly less nitrogen than both parents. The degree of heterosis was not affected by nitrogen level or genotype. Hence, when testing for heterosis for less thin juice nitrogen, all reasonable nitrogen fertility levels should be equally accurate. Even



though the five parental genotypes did not show differential specific combining ability when crossed in all combinations, it does not seem likely that this would hold true for the almost infinite number of genotypes in the species.

Betaine: Fortunately there was heterosis in the desirable direction (toward less betaine), with the midparents averaging 107% of the hybrids. In no case, however, did the  $F_1$  have significantly less betaine than both parents. The degree of heterosis was not affected by nitrogen level but was affected by  $F_1$  genotype. In other words, specific combining ability effects were different among some of the 10  $F_1$  combinations. Testing for hybrid performance could apparently be done at any reasonable nitrogen level.

Nitrate ( $NO_3^-$ ): This radical ion was present in relatively small quantity which was fortunate since there was considerable heterosis in the undesirable direction; the midparents were only 80% of the hybrids. The magnitude of heterosis was significantly decreased with increasing nitrogen fertilization and especially in the higher yielding hybrids. The  $F_1 \times N$  interaction was not significant. Thus if  $NO_3^-$  were to be seriously considered, one must be aware that there are likely to be large specific combining ability differences among hybrids and that hybrids will probably perform proportionately worse with increasing nitrogen fertilization.

Amino nitrogen: This is the nitrogen from amino compounds which are in general a very noxious class of compounds. Fortunately, amino N is present in relatively low quantity. It is also fortunate that heterosis is in the desirable direction, the midparent being, on the average, 109% of the hybrid. There are no cases, however, of significant best-parent heterosis. The nitrogen level did not significantly affect the expression of heterosis for less amino N but  $F_1$  genotype did; so there are apparently specific combining ability differences which would be worthy of consideration in a breeding program.

Sodium: This cation is a relatively important impurity which exhibited heterosis in the undesirable direction. The midparents averaged 97% of the  $F_1$ 's within nitrogen levels. Heterosis was in the desirable direction (less sodium) at 0 lbs. nitrogen but undesirable at 80 and 180 lbs.; however, this difference was not significant. There were significant differences among  $F_1$ 's for degree of heterosis. Hence, there are likely to be heterosis differences among hybrids for thin juice sodium, but little need be paid to the N level of tests.

Potassium: This is another important impurity component due to its relative abundance. The hybrids on the average had less K than their midparents and hybrid 6 had significantly less than its best parent. Percent heterosis for less K tended to decline with increasing nitrogen fertilization but not enough to be significant. There were significant differences between  $F_1$ 's for specific combining ability.

Calcium: Calcium is not an important impurity in thin juice. The quantity of Ca in our juice was relatively low. Most of the calcium in pressed juice as well as that added as lime is removed in the thin juice purification process. It is doubtful that genetic inference about calcium in the root can be accurately made from calcium determinations in thin juice.

Magnesium: This is another impurity present in low quantity since it is mostly removed in purification. There was one case of significant best-parent heterosis, hybrid 6, and the hybrids averaged considerably better (lower) than their midparents. However, magnesium is present in such low quantity it is hardly worthy of consideration.

Chloride: Even though present in relatively low quantity, this impurity is important by virtue of its effect of slowing crystallization. Chloride content decreased with increasing nitrogen. Among the 10 hybrids, average chloride content was less than midparent but there was no significant best-parent heterosis.  $F_1$  genotypes had a significant effect on heterosis; hence, there were specific combining ability differences for chloride content. For some  $F_1$ 's, increasing nitrogen fertilization tended to cause a decline in the magnitude of heterosis for less chloride. Even though this interaction was not significant it might bear consideration in a hybrid evaluation program.

### Discussion

Experiments in corn, tomatoes, and several other crops have shown that some heritable characteristics developed under a given nutritional environment do not necessarily find expression to the same extent when placed under different nutritional conditions. This can be classed as a type of genotype by environment interaction. The absence of this interaction for a particular character might indicate rather high heritability and would be an important factor in the expression of homeostasis, which is the genetic capacity to perform uniformly over a range of environments.

We know in general that genotype by environment interaction is important in sugar yield. In this study we have examined the effect of nitrogen fertility level on magnitude and direction of heterosis. By analyzing the ratios of best parent to hybrid and midparent to hybrid, our objective was to detect differential heterosis expression due to different nitrogen levels. Nitrate was the only character where heterosis was significantly affected by nitrogen level; the percent heterosis for less nitrate declined with increasing nitrogen. Heterosis for thin juice nitrogen, sodium, potassium, and chloride content was affected in the same direction as was nitrate but the effect was not great enough to be significant. For root yield and recoverable sugar there was a trend, though nonsignificant, toward greater heterosis with increasing nitrogen fertilization. In analyzing for magnitude of

heterosis there were no cases of significant interaction of  $F_1$  genotype and nitrogen level. For instance, increased nitrogen never caused increased heterosis in one  $F_1$  but decreased heterosis in another. If  $F_1$ 's in general do not show this interaction, then all  $F_1$ 's could be evaluated at one nitrogen level without fear of missing potentially valuable single-cross combinations. It seems reasonable to assume that this interaction might also be absent among 3-way and double-cross hybrids.

Midparent heterosis for lower quantities of thin juice impurities was present for seven characters. Nitrate and sodium showed heterosis for high quantity; this was midparent heterosis. The only case of significant best-parent heterosis was hybrid 6 for potassium. For the entire experiment the percentages that the midparents were of the  $F_1$ 's were 104% for nitrogen, 107% for betaine, 80% for nitrate, 109% for amino N, 97% for sodium, 107% for potassium, 116% for calcium, 113% for magnesium, and 115% for chloride. So except for nitrate and sodium the hybrids had less impurities than their midparents.

Since the magnitude of heterosis for betaine, nitrate, amino N, sodium, potassium, and chloride was significantly different between hybrids, it is likely that heterosis will be an important means of achieving lower quantities of these impurities. For total nitrogen it appears that all parental combinations would tend to give the same degree of heterosis. This may be due to a balancing effect of the various nitrogen compounds from which total nitrogen is derived. It would likely be more fruitful to search for heterosis for the individual impurities than for total nitrogen, since the different nitrogenous compounds may be quite differently genetically controlled. In our study 69% of the total nitrogen in both  $F_1$ 's and parents was consistently accounted for by the nitrogen from betaine, amino compounds, and nitrate. By weight, betaine is 7.3% and nitrate is 22.6% nitrogen. None of the impurities showed heterosis which even approached that exhibited for root weight. Heterosis for weight will remain as the first consideration in hybrid breeding programs with sucrose, amino nitrogen, potassium, betaine, sodium, nitrate, and chloride then being considered approximately in that order. Calcium and magnesium because of their low quantity are not worth considering in a breeding program. Purity and total nitrogen failed to show significant differences between hybrids for magnitude of heterosis. From past experiments we know that best-parent heterosis for purity does occur in certain genotypes. In this study the hybrid was near 100% of the best parent in most cases. Even though virtually complete dominance was shown in every hybrid, purity, by virtue of its direct effect on sugar recovery, should probably be ranked after sucrose in order of consideration in a breeding program. Progress toward less nitrogenous impurities could probably be achieved more rapidly by capitalizing on heterosis for betaine, amino N, and nitrate individually rather than total nitrogen.

For the most important characters percent increase due to heterosis was affected little by nitrogen fertilization. Hence, a hybrid testing program should apparently be conducted at commercially optimum or slightly higher nitrogen levels.



## PREDICTING PERFORMANCE OF DOUBLE CROSS HYBRIDS IN SUGARBEET

Garry A. Smith and Richard J. Hecker

After desirable inbreds have been selected for combining ability it then is necessary to test their performance in single, three-way, or double crosses. If double cross hybrids are the objective then the testing problem becomes one of number. With 20 inbred lines which give 190 different single crosses  $\binom{N^2-N}{2}$ , 14,535 different double crosses are possible  $\frac{3(N!)}{4!(N-4)!}$ . If these double crosses were replicated only 4 times, 58,140 plots would be required to test them. Obviously, if efficient prediction of the probable performance of double crosses could be made from single-cross performances, the work of the breeder would be greatly reduced.

In corn it is now generally accepted that prediction methods are rather accurate measures of the probable comparative performance of double crosses. Richey and Sprague in 1931 made one of the early studies of estimation methods but Jenkins in 1934 presented the first favorable evidence by correlating the yield of 42 double crosses with four methods of prediction. These four methods were essentially the same as the first four methods listed below.

A preliminary study on this subject was conducted in 1967 and was included in the 1968 report. This is a report of a greatly expanded study on the prediction of double cross performance conducted in 1969.

This study was designed to provide 5 predictions of double cross performance:

1. Mean of all 6 single crosses of the parents involved in any double cross.
2. Mean of the 4 nonparental single crosses.
3. Mean of all single crosses in which any of the 4 double cross parents are involved.
4. Mean of the red beet top crosses of the 4 parents in any double cross.
5. Mean of the two parental single crosses of any double cross.

Six inbred lines were utilized in this study. It was possible to obtain all 15 possible single crosses (excluding reciprocals) among these inbreds. Of the 45 possible double crosses involving these 6 inbreds it was possible to obtain 35 double crosses. In addition all of the 6 possible red beet top crosses were obtained. In the case of



prediction method 3, all 14 single-cross means (n-1) were available to compute the predicted values.

The experiment was designed as a triple lattice repeated four times to give 12 replications. Entries were grown in single row plots (19 feet long with a 10" spacing between plants within the rows). Each entry row was bordered on both sides by a common competitor.

Data were obtained for root yield (kilograms per plot), thin juice purity (%), sucrose (%), and recoverable sugar (kilograms per plot). Correlation coefficients were computed for actual vs. predicted values for each of the four characters measured. These correlation coefficients were computed in three ways. First, the top 15 performing double crosses (actual data) were correlated with the corresponding predicted values. Second, the remaining 20 (lower 20) double cross values were correlated with their corresponding predicted values. Third, correlations of the actual values of the 35 double crosses and their corresponding predicted values were computed.

After the top 15 double crosses for each character were determined from the actual data, the predicted double crosses were ranked from highest to lowest. These predicted rankings were then compared with the actual rankings of the double crosses. From these rankings the percentage of the actual top 15 double crosses that were accurately predicted (those that fell within the actual top 15 double crosses) was determined.

Table 1 presents the correlation coefficients of actual and predicted double-cross performance and the percentage of the top 15 entries that were predicted. According to the correlation coefficients for the top 15 double crosses, prediction method 1 was consistently as good or better than the other four methods for prediction of root yield, percent sucrose, and percent purity, and about equal to prediction method 2 for recoverable sugar. The relatively high negative value ( $r = -.652$ ) using method 5 for prediction of yield of the top 15 double crosses is interesting. This association would indicate that the predicted low 15 double crosses would be indicative of the high 15 double crosses actually obtained. When the correlations based on the lower 20 are compared, none of the 5 methods can be called superior for any character since in no case was the  $r$  value statistically significant. Comparison of the correlations based on the entire group of 35 double crosses would indicate that prediction methods 2 and 5 were slightly superior in predicting percent purity. In addition prediction 2 gave the highest  $r$  value for percent sucrose.

Table 2 summarizes the percent accuracy of predicting the top 15 double crosses. Prediction method 1 was as good as or better than the other four methods for predicting root yield, percent sucrose and recoverable sugar, but not for predicting percent purity. For percent purity, prediction 2 was indicated as the best predictor of double cross performance.

Correlation values for actual and predicted performance were compared with the percentages of the actual top 15 double crosses accurately predicted (Table 1). It was rather evident that the correlation values obtained appeared to have little if any relation to the percentage of the actual top 15 double crosses predicted. For example, for root yield prediction 1 (top 15) had a highly significant correlation of .620 whereas prediction 4 had a nonsignificant value of -.017; both of the prediction methods accurately predicted 9 of the top 15 double crosses (60%).

If only the results from the correlation of the 35 actual and predicted double crosses were used to select the best prediction method, then prediction method 1 would have been chosen only for prediction of root yield. If the correlation results from the lower 20 were used to select the best prediction method, then method 1 would most likely not have been chosen at all. If the correlation results of the top 15 double crosses were used to select the best prediction method then methods 1 and 5 would have been selected for yield, methods 1 and 4 for purity, method 1 for percent sucrose, and methods 1 and 2 for recoverable sugar. On the other hand, based on accuracy of prediction of the top 15 double crosses (Table 2) method 1 was the most consistent predictor.

Further critical statistical analyses are planned for these data.

Table 1. The correlation of actual and predicted double cross performance and the number and % of top 15 double crosses accurately predicted.

Group	Yield (kg/plot)					Purity %				
	Prediction method					Prediction method				
	1	2	3	4	5	1	2	3	4	5
Correlated										
Top 15	.620*	-.043	.005	-.017	-.652* <sup>1/</sup>	.223	.109	-.158	-.356	-.026
Lower 20	-.145	.044	-.203	.029	.223	.042	.139	-.148	-.131	.325
Total 35	.251	.198	-.010	.225	.069	.253	.388*	.032	-.272	.363*
Number and % of top 15 predicted	(9) 60	(8) 53.3	(6) 40	(9) 60	(9) <sup>2/</sup> 60	(9) 60	(10) 66.6	(6) 40	(6) 40	(9) 60
-----										
Group	Sucrose %					Recoverable sugar				
	Prediction method					Prediction method				
	1	2	3	4	5	1	2	3	4	5
Correlated										
Top 15	.506	.398	.302	.193	.147	.544*	.555*	.100	.105	.011
Lower 20	.155	.161	.202	.038	.099	-.315	.023	.333	.303	.032
Total 35	.327	.379*	.272	.097	.243	.066	.211	-.173	.231	.194
Number and % of top 15 predicted	(10) 66.6	(8) 53.3	(9) 60	(5) 33.3	(8) 53.3	(8) 53.3	(8) 53.3	(7) 46.6	(6) 40	(5) 33.3

<sup>1/</sup>  $r = .514$ ,  $r = .444$ ,  $r = .334$  required for significance at the .05 level for 15, 20, and 35 paired comparisons respectively.

<sup>2/</sup> Numbers in parentheses refer to the number of double crosses predicted which were among the actual top 15 double crosses.

Table 2. The accuracy of predicting double cross performance as % of the actual top 15 accurately predicted.

Prediction Method	Character measured			
	Yield	Purity (%)	Sucrose (%)	Recov. sugar
1	60	60	66.6	53.3
2	53.3	66.6	53.3	53.3
3	40	40	60	46.6
4	60	40	33.3	40
5	60	60	53.3	33.3

#### A SEARCH FOR APOMIXIS IN SUGARBEET

Garry A. Smith and Richard J. Hecker

A search for apomixis (seed production without fertilization) is currently being conducted by the authors. The preliminary search is basically a screening program in which varieties and various inbred lines are screened. Plants which are to be screened are pollinated by a red beet tester (genetically RRY) which has an intensely red hypocotyl and root. Crosses are made in field and greenhouse isolations. Entries to be screened are placed in isolation with a preponderance of red beet pollinator plants. Not only is it possible to screen green plants but also plants which have red hypocotyl or even light red roots. Seed is harvested from each female plant individually. The seed is then planted in rows in greenhouse flats. After the seedlings emerge they are checked for color. The seedling progeny of any plant failing to show at least one red seedling (hybrid with the red beet) are saved and placed in induction chambers for repeated crossing with the red beet tester.

To date the seedling progeny from 201 plants representing 10 varieties and inbreds have been screened. From these, 3 lines have been retained (2 from the same inbred) as representing possible apomicts.

Approximately 3000-4000 mother beets representing 20 different varieties or inbreds will be screened beginning in December 1969.



## STUDIES ON INDUCING MALE STERILITY IN SUGARBEET

R.J. Hecker and G.A. Smith

We reported in 1968 on experiments to induce male (pollen) sterility in sugarbeet. Two applications of oestrone (a female sex hormone produced in the ovaries) in water, taken up through the cut end of a leaf midvein resulted in 48% inviable pollen compared with 12% for the control.

During 1969 we conducted another experiment in which we used two chemicals, [oestrone and sodium 2,3-dichloroisobutyrate (FW-450)], two methods of application (uptake through cut midvein and foliar spray), three stages of application (premeiotic, meiotic, and postmeiotic), and two genotypes (52-305 and 52-334, both inbreds). The experiment was a factorial and included a water control and a no-treatment control.

Induced mother roots were planted in the greenhouse in January, treated, allowed to interpollinate, observed, and harvested for seed.

FW-450 was quite phytotoxic at all growth stages regardless of application method; phytotoxicity was similar to the results of earlier experiments with FW-450. The gametocidal effect of FW-450 was quite genotype specific; it resulted in as much as 99.8% inviable pollen when applied premeiotic to inbred 52-334. However, seed yield and germination were very low. This was probably a mixture of crossed and selfed seed since all plants were allowed to interpollinate. By comparison oestrone had no phytotoxic effects and induced pollen sterility of 24% to 80% dependent on genotype and treatment. The inbred 52-334 was more sensitive to treatment than 52-305. The water controls had 9% inviable pollen and the no-treatment controls had 7% inviable pollen. In examining pollen mother cells during meiosis we observed considerable apparent nondisjunction which could be a reason for failure of the pollen to develop.

We and others have had sufficient experience with FW-450 so that we feel it has little commercial promise due to its phytotoxicity and interaction with genotype. We feel oestrone shows some promise as a male gametocide since it does induce some pollen inviability and it is not phytotoxic. We plan to continue experimenting with this hormone as a male gametocide and also to test other potential gametocidal chemicals.

We would like to acknowledge the assistance in this study of Dr. P.S. Bhatnagar, USAID participant from Pantnagar, India, while he was working with us at Fort Collins, Colorado.

## SUGARBEET RESEARCH

1969 Report

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Michigan Sugar Company  
Monitor Sugar Division  
Northern Ohio Sugar Company  
Michigan Agricultural Experiment Station  
Minnesota Agricultural Experiment Station  
North Dakota Agricultural Experiment Station  
Red River Valley Sugarbeet Growers Association, Inc.

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EVALUATION OF SUGARBEET HYBRIDS AND BASIC BREEDING MATERIAL  
WITH LEAF SPOT AND/OR BLACK ROOT RESISTANCE

Prepared by G. J. Hogaboam

The cooperative evaluation program was continued in 1969 with the Farmers and Manufacturers Beet Sugar Association and its member companies as well as with The American Crystal Sugar Company, Holly Sugar Corporation, and Cornell University.

SECTION ONE: Agronomic Evaluation

Latin square variety tests were planted on three farms in the Michigan and two in the Ohio area. Six varieties were evaluated in all tests. The Schroeder Farm at Ottawa, Ohio and the Schindler Farm at Kawkawlin, Michigan each had 2 tests; one designed for hand harvest with plots 30 feet long and 4 rows wide, and one designed for machine harvest with plots 120 feet long and 1 row wide, with a row of commercial beets between each plot row. In Ohio both tests were hand harvested, while the machine was used for the machine harvest test in Michigan. Yields were significantly less with machine harvest as were number of beets per 100'. The variety by harvest interaction was not significant in either case.

In all tests, SP6322-0 yielded less than the 5 hybrids in the test. Although some tests indicated significant differences, these differences averaged out over all locations to where outstanding hybrids were not indicated.

SECTION TWO: Hybrid Screening Tests

In the Michigan and Ohio tests combined 4 hybrids were significantly above average in yield of roots per acre: SP(6423-01 x 65406)ms x SP6322-0, UI(100363 x 2161)ms x SP6322-0, (SP6121-01 x EL31)ms x SP6322-0, and SP65550-1 x SP6322-0. In recoverable sugar per ton in the combined Michigan tests the following hybrids were significantly above the average: SP64218-01 x CT7 (but significantly below average in yield), SL(129 x 133)ms x SP6828-01, SP65550-1 x SP6322-0, SL(129 x 133)ms x SP6322-0, UI(100363 x 2161)ms x SP6322-0, and SP6423-01 x CT7. When both yield and quality are combined as sugar per acre for the 3 Michigan tests, then only UI(100363 x 2161)ms x SP6322-0 and SP65550-1 x SP6322-0 exceeded the average of all hybrids significantly.

CONSOLIDATION OF FARM DATA AND NOTES  
BY JERROLD L. BROWN

AGRONOMIC EVALUATION, 6x6 latin square variety tests. The tests were conducted by the Farmers and Manufacturers Beet Sugar Association with the cooperation of the Sugar Company in whose area the farm was located. With two exceptions, all plots were 4 rows wide and 30 feet long trimmed to 28 feet for harvest. The two exceptions were test planned for machine harvest where one row plots 120 feet long trimmed to 118 feet were used. Each plot in the machine harvest experiment had a row of commercial beets between it and the next plot. A ten beet sugar sample was taken from each plot. Only competitive beets were taken for sugar samples except in the one test which was machine harvested where random beets were taken. Data for the individual farms follow:

BUCKEYE SUGARS, INC.: James Schroeder farm, Ottawa, Ohio; two tests (one designed for hand and the other machine harvest), 1966 tomatoes, 1967 soy beans, 1968 fallow, 1969 beets; plow down fertilizer 400 pounds of 5-20-20 plus 45 pounds of actual N (Urea), in row fertilizer of 250 pounds of 6-24-12 + 2% mn, medium to severe leaf spot exposure, both tests were hand harvested; an accident rendered sugar data from the hand-harvested test invalid. Both tests planted April 11, hand harvest test was harvested October 14 for 186 days growing, while the "machine" harvest test was harvested October 21 for 193 days of growing. A reliable test.

NORTHERN OHIO SUGAR COMPANY: Mr. Alvin Heilman's farm, Old Fort, Ohio; selected for leaf spot nursery because of beets in 1967 and 1968, plowed down 100-100-240, in row fertilizer 150 pounds of 6-24-12, severe leaf spot exposure, wireworm damage in one replication, adequate moisture during growing season of 181 days from April 15 to October 13. A reliable test.

MICHIGAN SUGAR COMPANY: Rudy Hetzner farm, Saginaw, Michigan; 1967 alfalfa, 1968 navy beans, 1969 beets, fertilization of beets 450 pounds of 18-46-0 with 2% mn +  $\frac{1}{2}\%$  B, and 100 pounds 33% N, slight infestation of root aphids, growing season of 163 days from April 26 to October 6, wet at planting time with August and September extremely dry; reliability excellent.

Elmer Frahm's farm, Frankenmuth, Michigan; 1967 and 1968 alfalfa, 1969 beets, fertilization 450 pounds of 18-46-0 with 2% mn, slight infestation of root aphids, dry August and September, growing season of 160 days from May 2 to October 9; reliability excellent.

MONITOR SUGAR DIVISION: Thomas Schindler farm, Kawkawlin, Michigan; two tests (one hand harvested, the other machine harvested), 1967 wheat, 1968 navy beans, 1969 beets, fertilization 750 pounds of 8-32-16 + 2% mn and B in the row with 60 pounds of actual N sidedressed, dry during August and September, growing season 160 days, from May 1 to October 8; reliability excellent.

HYBRID SCREENING TESTS, lattice designs with 8 replications. The tests were conducted by the Farmers and Manufacturers Beet Sugar Association with the cooperation of the sugar company in whose area the farm was located. Single row plots were used; at Russell Brothers farm in Belmore, Ohio the

plots were 67 feet long with 65 feet harvested and the row width was 32 inches, while the other three tests had 28 feet of harvest row with 28 inch row width. Ten competitive beets were taken for sugar samples from each plot. Data for the individual farms follow:

BUCKEYE SUGARS, INC.: Russell Brothers farm, Belmore, Ohio; 1967 tomatoes, 1968 corn, 1969 beets, plowed down 40-80-120, in row 200 pounds of 6-24-12 + 2% mn, 80 pounds actual N (anhydrous ammonia); moisture was adequate to excess during the 192 day growing season from April 14 to October 23; reliability of test, good.

MICHIGAN SUGAR COMPANY: Dale Smith farm, Alma, Michigan; 1967 corn, 1968 beans, 1969 beets, fertilizer data missing, wet period in the spring, blackroot was noted until thinning time; growing season 160 days from May 3 to October 10, Rhizoctonia reduced harvest stand in some plots, data were corrected for missing feet of row; reliability of test, good.

MONITOR SUGAR DIVISION: Howard Hayward farm, Bay City, Michigan; 1966 beans and rye, 1967 potatoes, 1968 beans, 1969 beets, fertilizer broadcast 600 pounds 0-25-25, in row 600 pounds 8-32-16 + mn and zn plus 55 pounds liquid N, dry August and September; growing season 154 days from May 2 to October 3; reliability of test excellent.

Thomas Schindler farm, Kawkawlin, Michigan; 1967 wheat, 1968 beans, 1969 beets, fertilizer 750 pounds of 8-32-16 + 2% mn and B in row 60 pounds actual N, dry August and September, growing season 154 days from May 1 to October 2; reliability of test excellent.

Schroeder Farm  
Ottawa, Ohio  
1969, Hand harvest

	Percent of General Mean				Actual	
	Recov. Sugar/A Lbs.	Roots per Acre Tons	Sugar per Ton Lbs.	Clear Juice Purity %	Beets per 100' row	Leaf Spot Rating 9/16
SL(129x133)ms x SP6322-0		99.0			109	3.50
UI(100363x2161)ms x SP6322-0		106.6			109	3.00
SP6322-0		94.4			108	2.00
(EL31C2xSP6121-0)ms x SP6322-0		101.1			114	2.33
(SP6121-01xEL31)ms x SP6322-0		104.3			110	2.17
SL(129x133)ms x SP6528-01		94.6			112	3.83
General Mean (actual)		31.03			110	2.81
SE Mean		1.91			2.89	.16
Significant Difference (19:1)		NS			NS	.47
Coefficient of Variation (%)		15.14			6.44	13.76

Schroeder Farm  
Ottawa, Ohio  
1969, "Machine" harvest

	Percent of General Mean				Actual	
	Recov. Sugar/A Lbs.	Roots per Acre Tons	Sugar per Ton Lbs.	Clear Juice Purity %	Beets per 100' row	Leaf Spot Rating
SL(129x133)ms x SP6322-0	106.9	106.3	100.4	100.1	116	
UI(100363x2161)ms x SP6322-0	105.2	106.7	98.8	99.4	109	
SP6322-0	91.8	89.5	102.0	100.7	118	
(EL31C2xSP6121-0)ms x SP6322-0	97.6	100.5	97.2	100.0	116	
(SP6121-01xEL31)ms x SP6322-0	98.0	99.2	99.2	99.5	112	
SL(129x133)ms x SP6528-01	100.5	97.8	102.3	100.4	113	
General Mean (actual)	6759	30.9	219	91.83	114	
SE Mean	240.8	0.90	3.88	0.434	3.93	
Significant Difference (19:1)	NS	8.4	NS	NS	NS	
Coefficient of Variation (%)	8.7	7.2	4.4	2.7	8.5	



Alvin Heilman Farm  
Old Fort, Ohio  
1969

Alvin Heilman Farm Old Fort, Ohio 1969		Percent of General Mean				Actual			
		Recov. Sugar/A Lbs.	Roots per Acre Tons	Sugar per Ton Lbs.	Sucrose %	Clear Juice Purity %	Beets per 100' row	Leaf Spot Rating 8/26	
SL(129x133)ms	x	SP6322-0	97.9	103.3	94.4	95.7	99.4	110	3.5
UI(100363x2161)ms	■	SP6322-0	102.4	102.8	99.9	99.8	100.1	96	3.4
SP6322-0			98.9	93.5	106.1	106.4	99.8	111	2.5
(EL31C2xSP6121-0)ms	x	SP6322-0	98.3	98.1	100.4	99.7	100.4	123	3.0
(SP6121-01xEL31)ms	x	SP6322-0	96.6	99.5	96.3	97.2	99.6	113	2.9
SL(129x133)ms	■	SP6528-0	106.0	102.8	102.9	101.3	100.8	116	3.5
General Mean (actual)			4157	20.0	208	12.04	93.57	112	
SE Mean			261	.69	7.85	.415	.391	5.7	
Significant Difference (19:1)			NS	NS	NS	NS	NS	NS	
Coefficient of Variation (%)			15.4	8.5	9.3	8.4	1.0	12.7	

Hetzner Farm  
Saginaw, Michigan  
1969

Hetzner Farm Saginaw, Michigan 1969		Percent of General Mean				Actual		
		Recov. Sugar/A Lbs.	Roots per Acre Tons	Sugar per Ton Lbs.	Sucrose %	Clear Juice Purity %	Beets per 100' row	Leaf Spot Rating
	x SP6322-0	107.4	107.6	99.8	100.8	99.5	123	
	x SP6322-0	106.2	105.3	100.8	100.3	100.3	113	
	SP6322-0	87.6	87.5	100.1	99.4	100.4	121	
	(EL31C2xSP6121-0)ms	101.1	99.8	101.2	100.4	100.4	120	
	x SP6322-0	99.8	101.4	98.4	99.3	99.6	118	
	SL(129x133)ms	97.9	98.5	99.6	99.8	99.9	119	
General Mean (actual)		7148	21.4	334	19.68	92.34	119	
SE Mean		123	.40	4.7	.219	.296	3.3	
Significant Difference (19:1)		5.1	5.5	NS	NS	NS	NS	
Coefficient of Variation (%)		4.2	4.6	3.5	2.7	0.8	6.7	

Schindler Farm  
Kawkawlin, Michigan  
1969, Hand harvest

	Percent of General Mean				Actual	
	Recov. Sugar/A Lbs.	Roots per Acre Tons	Sugar per Ton Lbs.	Sucrose % %	Beets per 100' row	Leaf Spot Rating
SL(129x133)ms	99.9	99.7	100.2	100.0	127	
x SP6322-0						
UI(100363x2161)ms	99.2	99.9	99.2	99.2	122	
SP6322-0	94.2	95.4	98.9	99.0	129	
(EL31C2xSP6121-0)ms	99.0	99.7	99.2	100.1	129	
x SP6322-0						
(SP6121-01xEL31)ms	105.5	105.6	100.0	99.9	130	
x SP6528-0						
SL(129x133)ms	102.3	99.8	102.5	101.6	126	
General Mean (actual)	7477	22.5	333	19.29	127	
SE Mean	202	.61	3.85	.170	3.83	
Significant Difference (19:1)	NS	NS	NS	NS	NS	
Coefficient of Variation (%)	6.6	6.6	2.8	2.2	7.4	

Schindler Farm  
Kawkawlin, Michigan  
1969, "Machine" harvest

	Percent of General Mean				Actual	
	Recov. Sugar/A Lbs.	Roots per Acre Tons	Sugar per Ton Lbs.	Sucrose % %	Beets per 100' row	Leaf Spot Rating
SL(129x133)ms	103.8	101.8	101.9	101.1	112	
x SP6322-0						
UI(100363x2161)ms	102.1	103.8	98.5	99.7	111	
SP6322-0	90.1	89.2	101.0	100.8	103	
(EL31C2xSP6121-0)ms	101.4	101.6	99.8	99.6	110	
x SP6322-0						
(SP6121-01xEL31)ms	99.8	101.1	98.5	98.9	109	
x SP6528-0						
SL(129x133)ms	102.7	102.6	100.3	99.9	110	
General Mean (actual)	6269	18.4	341	19.74	109	
SE Mean	203	.58	3.35	.133	3.33	
Significant Difference (19:1)	NS	9.3	NS	NS	NS	
Coefficient of Variation (%)	7.9	7.7	2.4	1.7	7.5	

Frahm Farm Frankenmuth, Michigan 1969		Percent of General Mean				Actual	
		Recov. Sugar/A Lbs.	Roots per Acre Tons	Sugar per Ton Lbs.	Clear Juice Purity %	Beets per 100' row	Leaf Spot Rating
SL(129x133)ms	x SP6322-0	98.6	97.8	100.8	101.1	115	
UI(100363x2161)ms	x SP6322-0	101.9	98.1	104.1	103.5	114	
SP6322-0		93.4	97.4	95.9	96.6	127	
(EL31C2xSP6121-0)ms	x SP6322-0	106.9	104.7	102.3	102.4	125	
(SP6121-01xEL31)ms	x SP6322-0	97.0	99.9	96.8	97.5	125	
SL(129x133)ms	x SP6528-0	102.2	102.1	100.1	98.9	123	
General Mean (actual)		7233	20.6	351	20.37	122	
SE Mean		256	0.67	4.86	0.31	3.7	
Significant Difference (19:1)		NS	NS	4.1	NS	NS	
Coefficient of Variation (%)		8.7	8.0	3.4	3.7	7.5	

1969 Area Evaluation:  
Russell Bros. Farm  
Belmore, Ohio

1959 Area Evaluation			Performance as % of General Mean				Actual	
Russell Bros. Farm			Recov.	Roots	Sugar		Clear	Beets
Belmore, Ohio			Sugar/A	per	per		Juice	per
FEMALE		MALE		Acre	Ton	Sucrose	Purity	100'
CMS	"O" type	Pollinator	Lbs.	Tons	Lbs.	%	%	row
SL133		02 clone		103.3		99.5		109
"		SP6629-0		107.4		101.8		109
SP66221-1		SP6322-0		101.7		100.1		123
SP66333-1		SP6322-0		104.5		99.7		123
UI2161	UI4661	02 clone(4n)		111.5		102.8 4		130
SP65550-1		SP6322-0		115.0 2		102.8 4		126
SP6423-01	UI4661	02 clone(4n)		101.4		100.1		122
SP6423-01		CT7		95.6		97.2		121
SP64218-01		"		89.4		105.5		120
"		02 clone		94.2		103.3 2		121
"		SP6322-0		98.4		100.6		122
SP6423-01	SP6621-0	02 clone(4n)		98.3		99.7		119
SP65406-01	SP6442	SP6322-0		103.7		97.7		125
SP6423-01	SP65406	"		118.2 1		98.7		122
"	EL31	"		97.7		100.0		111
"	"	02 clone		89.4		100.6		124
SP6121-01	"	"		100.8		103.2 3		123
"	"	CT7		93.5		101.2		114
"	"	SP6322-0		107.7		99.1		128
EL31C2	SP6121-0	"		100.2		98.6		122
"	"	CT7		93.4		100.8		116
"	"	02 clone		96.6		99.0		137
SP6540-01	SP663465-0	SP6322-0		100.3		99.4		117
UI1861	"	"		98.8		100.3		137
UI2161	"	"		101.1		97.7		121
UI100363	"	"		110.4		98.7		128
"	UI2161	"		113.5 3		99.1		136
"	"	SP6828-01		103.3		99.4		122
SL129	SL133	"		109.0		103.4 1		121
"	"	SP6322-0		112.6 2		102.7		126
ACS(5H0 x 6)ms		54-604		76.9		99.9		73
SL(129 x 133)ms		"		97.4		96.1		108
SL(129 x 133)ms		63-401		88.1		97.8		101
ACS(5H0 x 6)ms		66-406-0		100.2		98.3		100
(AI <sub>1</sub> x AI <sub>2</sub> )ms		62-4T18		82.8		99.7		113
American #3 Hybrid "T" Size 2				83.8		95.4		111
General Mean				23.2		15.0		119
Significant Difference (19:1)				11.8		4.8		13
Coefficient of Variation (%)				12.0		4.9		11.5



1969 Area Evaluation:  
Smith Farm  
Alma, Michigan

		Performance as % of General Mean					Actual	
		Recov.	Roots	Sugar		Clear	Beets	
		Sugar/A	per	per	Sucrose	Juice	per	
FEMALE	MALE	Lbs.	Acre	Ton	%	Purity	100'	
CMS	"O" type	Pollinator		Lbs.		%	row	
SL133		02 clone	95.3	100.2	95.3	95.4	98.5	109
"		SP6629-0	96.5	94.0	102.5	102.1	100.2	100
SP66221-1		SP6322-0	102.6	107.4	95.6	96.3	99.7	122
SP66333-1		"	105.5	108.8	97.0	98.3	99.4	101
UI2161	UI4661	02 clone(4n)	93.9	98.9	95.3	98.4	98.5	101
SP65550-1		SP6322-0	111.17	105.5	105.2	103.6	100.8	120
SP6423-01	UI4661	02 clone(4n)	102.7	104.4	98.3	97.4	100.6	108
SP6423-01		CT7	99.0	94.5	104.7	104.1	100.3	118
SP64218-01		"	99.9	91.8	108.7	108.4	100.1	118
"		02 clone	98.6	97.0	101.1	101.0	101.0	116
"		SP6322-0	99.1	98.6	100.4	100.6	99.9	114
SP6423-01	SP6621-0	02 clone(4n)	94.5	95.5	98.9	101.0	99.0	98
SP65406-01	SP6442	SP6322-0	101.3	106.7	94.8	97.4	98.8	120
SP6423-01	SP65406	"	103.3	108.5	95.2	98.0	98.6	122
"	EL31	"	97.4	102.4	95.2	96.6	99.4	111
"	"	02 clone	96.5	96.5	100.0	100.8	99.6	110
SP6121-01	"	"	101.4	105.5	96.0	98.5	98.8	125
"	"	CT7	103.6	100.8	102.7	103.4	99.7	102
"	"	SP6322-0	106.8	111.1	95.9	97.9	99.1	121
EL31C2	SP6121-0	"	99.2	103.6	95.6	96.8	99.5	120
"	"	CT7	102.0	99.7	102.2	103.4	99.5	112
"	"	02 clone	103.8	105.5	98.1	99.9	99.2	108
SP6540-01	SP663465-0	SP6322-0	94.0	98.2	95.3	96.8	99.3	123
UI1861	"	"	95.7	93.7	101.8	101.6	100.1	113
UI2161	"	"	104.3	106.7	97.5	98.9	99.4	117
UI100363	"	"	97.8	96.0	101.7	100.0	100.9	120
"	UI2161	"	113.6	110.1	103.1	101.6	100.8	121
"	"	SP6828-01	108.7	105.8	102.5	99.5	101.6	114
SL129	SL133	"	104.1	98.9	105.3	101.7	101.8	113
"	"	SP6322-0	104.2	99.3	104.7	100.8	102.0	114
ACS(5H0 x 6)ms		54-604	91.6	88.8	103.0	101.0	101.0	84
SL(129 x 133)ms		"	97.4	93.6	104.2	101.4	101.4	105
SL(129 x 133)ms		63-401	96.9	96.4	100.3	99.0	100.7	98
ACS(5H0 x 6)ms		66-406-0	97.3	97.0	100.4	98.5	101.1	106
(AI <sub>1</sub> x AI <sub>2</sub> )ms		62-4T18	86.4	86.4	100.2	99.6	100.3	114
American #3 Hybrid "T" Size 2			94.2	92.9	101.5	100.6	100.5	115
General Mean			8911	30.7	291	16.73	93.55	113
Significant Difference (19:1)			10.8	10.1	4.2	3.9	1.1	13
Coefficient of Variation (%)			11.0	10.2	4.2	3.9	1.1	11.8

1969 Area Evaluation:  
Hayward Farm  
Bay City, Michigan

		Performance as % of General Mean					Actual
		Recov.	Roots	Sugar		Clear	Beets
		Sugar/A	per	per		Juice	per
		Lbs.	Acre	Ton	Sucrose	Purity	100'
			Tons	Lbs.	%	%	row
FEMALE	MALE						
CMS	"0" type	Pollinator					
SL133		02 clone	102.7	102.3	100.3	100.2	122
"		SP6629-0	92.9	91.3	101.8	100.5	102
SP66221-1		SP6322-0	107.5 2	108.6	98.9	99.1	133
SP66333-1		"	95.4	97.6	97.3	98.2	107
UI2161	UI4661	02 clone(4n)	96.6	99.4	97.3	98.2	109
SP65550-1		SP6322-0	108.3 1	105.2	102.9	101.9	133
SP6423-01	UI4661	02 clone(4n)	93.5	96.0	97.3	98.2	119
SP6423-01		CT7	100.0	97.8	102.1	101.0	131
SP64218-01		"	102.4	98.2	104.1	104.3	128
"		02 clone	94.0	96.0	97.7	100.2	125
"		SP6322-0	100.0	100.0	100.1	101.0	125
SP6423-01	SP6621-0	02 clone(4n)	95.0	96.0	98.8	98.5	104
SP65406-01	SP6442	SP6322-0	101.7	101.9	99.9	100.1	122
SP6423-01	SP65406	"	107.1	108.0	99.1	99.3	131
"	EL31	"	101.4	102.9	98.5	98.6	125
"	"	02 clone	98.3	97.4	100.8	100.6	116
SP6121-01	"	"	99.9	103.1	97.0	97.4	124
"	"	CT7	94.5	91.7	102.9	102.3	122
"	"	SP6322-0	102.0	106.2	96.1	97.0	120
EL31C2	SP6121-0	"	107.0 2	108.4	98.8	98.8	132
"	"	CT7	102.8	100.0	102.8	102.4	124
"	"	02 clone	95.8	96.0	99.7	99.6	127
SP6540-01	SP663465-0	SP6322-0	98.8	99.8	99.4	99.6	120
UI1861	"	"	93.2	91.2	102.5	101.5	118
UI2161	"	"	103.9	104.6	99.2	99.4	130
UI100363	"	"	97.4	98.0	99.3	99.4	125
"	UI2161	"	101.9	100.7	101.3	101.4	126
"	"	SP6828-01	102.5	101.9	100.3	99.3	130
SL129	SL133	"	101.6	98.4	103.2	101.7	128
"	"	SP6322-0	102.2	101.5	100.6	100.2	127
General Mean			7561	21.3	356	20.60	123
Significant Difference (19:1)			9.5	8.8	3.4	2.5	12
Coefficient of Variation (%)			9.7	8.9	3.5	2.5	9.9

1969 Area Evaluation:  
Schindler Farm  
Kawkawlin, Michigan

			Performance as % of General Mean					Actual
FEMALE		MALE	Recov.	Roots	Sugar		Clear	Beets
CMS	"0" type	Pollinator	Sugar/A	per	per	Sucrose	Juice	per
			Lbs.	Acre	Ton	%	Purity	100'
				Tons	Lbs.		%	row
SL133		02 clone	98.7	96.6	102.5	102.0	100.2	104
"		SP6629-0	92.8	92.5	100.7	101.2	99.7	87
SP66221-1		SP6322-0	99.3	104.0	95.6	97.9	98.9	116
SP66333-1		"	104.8	106.0	98.5	98.1	100.2	137
UI2161	UI4661	02 clone(4n)	93.8	96.8	96.8	97.5	99.7	99
SP65550-1		SP6322-0	107.2 <sup>4</sup>	103.2	103.7	100.7	101.5	112
SP6423-01	UI4661	02 clone(4n)	101.2	105.0	96.3	96.9	99.7	120
SP6423-01		CT7	95.5	92.9	102.8	101.6	100.6	129
SP64218-01		"	86.0	79.5	108.1	106.6	100.6	114
"		02 clone	98.7	95.5	103.3	102.5	100.4	118
"		SP6322-0	102.4	100.9	101.8	101.4	100.2	125
SP6423-01	SP6621-0	02 clone(4n)	86.9	89.2	97.1	98.7	99.2	94
SP65406-01	SP6442	SP6322-0	110.2 <sup>2</sup>	111.0	99.2	99.9	99.7	121
SP6423-01	SP65406	"	102.4	104.8	97.6	99.8	99.0	119
"	EL31	"	104.1	104.8	98.9	100.0	99.5	119
"	"	02 clone	96.9	99.0	97.8	100.5	98.8	122
SP6121-01	"	"	99.8	99.7	100.0	99.6	100.2	125
"	"	CT7	90.3	91.0	98.6	99.1	99.7	111
"	"	SP6322-0	101.8	105.2	96.9	97.2	99.9	120
EL31C2	SP6121-0	"	110.7 <sup>2</sup>	112.4	98.5	97.7	100.4	128
"	"	CT7	89.2	90.4	98.6	99.3	99.7	124
"	"	02 clone	98.9	103.8	95.1	97.3	98.9	116
SP6540-01	SP663465-0	SP6322-0	102.8	105.4	97.5	99.2	99.2	124
UI1861	"	"	97.2	97.6	99.6	99.1	100.2	128
UI2161	"	"	98.7	100.7	97.9	98.9	99.5	114
UI100363	"	"	99.0	102.5	96.4	97.5	99.4	131
"	UI2161	"	121.6 <sup>1</sup>	114.9	105.9	102.5	101.6	127
"	"	SP6828-01	102.7	100.3	102.5	101.4	100.5	115
SL129	SL133	"	104.4	98.0	106.2	103.0	101.5	107
"	"	SP6322-0	102.0	96.6	105.7	102.9	101.4	116
General Mean			6488	20.2	321	18.65	93.03	117
Significant Difference (19:1)			10.7	9.2	5.0	3.3	1.5	14
Coefficient of Variation (%)			10.8	9.3	5.1	3.3	1.5	11.8

Cooperator: Northern Ohio Sugar Company by Phil Brimhall, Alvin Erichsen, Akio Suzuki, R. K. Oldemeyer and D. L. Sunderland

Location: Earl Longanbach Farm, Fremont, Ohio

Year: 1969

(Results given as 8 plot averages in % of SP5822-0)<sup>(b)</sup>

Strain	Recoverable <sup>(a)</sup>		Sugar Content	Thin Juice App. Purity
	Sugar Yield	Root Yield		
SP67555-01 x SP6322-0	123.3	121.7	101.0	99.8
SP66350-01 x SP6322-0	112.6	112.8	97.8	100.5
(SP6621-01 x SP663465-0) x SP6322-0	120.7	116.8	104.0	99.9
(SP6423-01 x SP663465-0) x SP6322-0	111.3	109.5	100.8	100.1
(SP6643 x 027 x SP663465-0) x SP6322-0	134.5 <sup>+</sup>	138.9 <sup>+</sup>	98.9	99.0
SP6423-01 x SP65331-3	134.1 <sup>+</sup>	143.6 <sup>+</sup>	95.5	98.7
SP6423-01 x SP65783-3	121.8	120.4	102.2	99.4
SP6621-01 x SP65783-3	104.9	107.2	96.9	99.9
SP6423-01 x SP6828-01 + 02	129.7	129.2	102.5	99.3
SP6621-01 x SP6828-01 + 02	127.7	130.7	99.2	99.0
SP663465-02 x SP6829-0	85.8	81.6	101.9	100.0
SL133 x SP6528-01	97.0	97.2	100.6	99.9
SL133 x SP6322-0	108.7	108.1	99.6	100.5
SL133 x 02 clone	113.6	109.4	103.0	100.0
SL133 x SP6629-0	85.2	87.1	97.8	100.0
SP6721-01 x SP6322-0	116.9	117.7	99.9	99.8
SP6721-01 x 02 clone	70.8	74.4	96.1	99.5
SP6423-01 x SP6322-0	93.2	96.6	96.9	99.8
SP6423-01 x 02 clone	80.4	80.9	98.5	99.8
SP6423-01 x SP6629-0	108.3	107.9	101.7	99.3
SP64218-01 x SP6322-0	121.0	117.7	102.9	99.9
SP64218-01 x 02 clone	91.8	91.0	101.4 <sup>+</sup>	99.9 <sup>+</sup>
SP64502-01 x SP6528-01	91.0	82.6	106.8 <sup>+</sup>	101.3 <sup>+</sup>
SP64502-01 x 02 clone	98.4	92.9	105.9 <sup>+</sup>	100.1
(SP65406-01 x SP6442) x SP6322-0	116.3	121.2	96.8	99.1
(SP6423-01 x EL31) x SP6322-0	100.2	98.2	101.9	99.8
(SP6423-01 x EL35) x SP6322-0	123.4	116.6	103.0	100.9
SP6621-01 x SP6528-01	93.3	91.3	99.8	101.2
SP6621-01 x SP6629-0	87.1	90.2	96.7	100.4
(EL31C2 x SP6121-0) x SP6528-01	113.2	117.3	99.2	98.9
(EL31C2 x SP6121-0) x SP6322-0	138.1 <sup>+</sup>	135.6 <sup>+</sup>	100.7	100.5
(SL129 x 133) x SP6322-0	137.9 <sup>+</sup>	137.9 <sup>+</sup>	101.5	99.5
(SP64502-01 x SP6442-0) x SP6322-0	104.8	102.7	101.1	100.0
(SP6121-01 x EL31) x SP6322-0	138.9 <sup>+</sup>	137.0 <sup>+</sup>	101.5	99.9
(UI100363 x SP6121-0) x SP6528-01	102.9	102.0	101.1	100.0
(UI100363 x SP6121-0) x SP6322-0	110.6	106.7	100.3	100.7
(UI100363 x UI2161) x SP6322-0	91.3	94.2	97.5	99.7
(UI12163 x SP6121-0) x SP6322-0	111.1	110.8	100.6	100.0
(FC505 x EL31) x SP6322-0	92.7	95.7	98.1	99.5
EL35 x SP6528-01	116.8	111.4	102.4	100.7
EL35 x SP6322-0	98.9	97.5	100.4	100.4
EL35 x 02 clone	128.6	119.0	104.6	101.2
(SP6121-01 x EL35) x SP6322-0	123.3	124.3	99.5	99.7
(EL31C1 x SP6121-0) x 02 clone	84.6	85.7	99.0	100.1
(EL32C2 x EL31) x 02 clone	118.4	125.1	98.3	98.8
(EL32C2 x SP6121-0) x SP6322-0	89.6	93.9	97.3	98.9
CV (%)	30.49	28.48	5.36	1.31
Sm/Gen. Mean (%)	10.78	10.07	1.89	0.46
LSD 5% pt. (% of SP5822-0)	33.13	30.83	5.49	1.30

+ Significantly above SP5822-0 at 5% point.

- Significantly below SP5822-0 at 5% point.

(a Calculated by computer from formula used since 1954

(b Means for SP5822-0 are:

Recoverable sugar	3356 lbs. per acre
Roots	14.7 tons per acre
Sugar	13.45 %
Purity	92.53 %



NORTHERN OHIO SUGAR COMPANY, LONGANBACH FARM (cont.)

Variance Table

Source of Variation	(lbs.) Recov. Sugar <sup>(a)</sup>		(lbs.) <sup>(a)</sup> Roots		(% Sugar		(% Purity	
	D.F.	M.S.	D.F.	M.S.	D.F.	M.S.	D.F.	M.S.
Replicates	7	10.300	7	840.062	7	0.440	7	1.950
Varieties	48	2.902**	48	224.481**	48	0.883**	48	2.625**
Random Block Error	300	1.356	309	90.506	316	0.569	306	1.468
Blocks (Elim. Var.)	48	1.594	48	105.445	48	0.836	48	1.456
Component (A)	36	1.733	36	118.307	36	0.815	36	1.646
Component (B)	12	1.175	12	66.857	12	0.898	12	0.888
Intra-Block Error	252	1.310	261	87.759	268	0.522	258	1.471
Total	355	1.741	364	122.588	371	0.608	361	1.631

(a) Pounds per plot

\*\* Significant difference among varieties at 1% level

AGRONOMIC EVALUATION TEST, 1969

USDA Varieties

Conducted by: Phil Brimhall, Akio Suzuki, A. W. Erichsen, R. K. Oldemeyer and  
D. L. Sunderland

Location: Fremont, Ohio

Cooperator: Northern Ohio Sugar Company, Fremont, Ohio

Date of Planting: April 11, 1969

Date of Harvest: October 16, 1969

Experimental Design: Simple Lattice Design

Size of Plots: 1 row x 25 feet x 8 replicates  
30-in row spacing

Harvest Area/plot: 1 row x 18 feet

Samples for Sucrose and Purity Determinations: 1 sample per plot

Recent Field History: Tomatoes 1968, Spring plowed

Fertilization of Beet Crop: Plow down 130-100-125, Starter 150 lbs 6-24-12

Leaf Spot Exposure: Very mild, no readings were made

Black Root Exposure: Mold early seedling disease, Chronic Aphanomyces from  
July-September

Other Diseases: None noted

Soil and Seasonal Conditions: Soil was a silt loam. Poor growing conditions due to  
excessive ppt. during May, June and July.

Reliability of Test: Fair-poor

Cooperator: Northern Ohio Sugar Company by Phil Brimhall, Alvin Erichsen, Akio Suzuki, R. K. Oldemeyer and D. L. Sunderland

Location: Alvin Heilman Farm, Old Fort, Ohio

Year: 1969

(Results given as 8 plot averages in % of SP5822-0)<sup>(c)</sup>

Strain	Recoverable <sup>(b)</sup>			Thin	Leaf <sup>(a)</sup>
	Sugar Yield	Root Yield	Sugar Content	Juice App. Purity	
SP67555-01 x SP6322-0	95.9	99.0	98.8	99.7	2.4
SP66350-01 x SP6322-0	104.2	106.4	100.3	99.7	1.9
(SP6621-01 x SP663465-0) x SP6322-0	112.5	118.6 <sup>+</sup>	98.4	98.6	2.1
(SP6423-01 x SP663465-0) x SP6322-0	112.6	116.6	97.0	100.5	2.6
(SP6643 x 027 x SP663465-0) x SP6322-0	101.2	109.9	95.7	98.3	2.6
SP6423-01 x SP65331-3	107.9	108.4	101.7	99.6	2.4
SP6423-01 x SP65783-3	87.3	97.9	92.4 <sup>-</sup>	98.3	2.5
SP6621-01 x SP65783-3	100.8	111.2	90.9 <sup>-</sup>	98.8	2.1
SP6423-01 x SP6828-01 + 02	108.5	113.0	98.2	98.4	2.5
SP6621-01 x SP6828-01 + 02	102.7	104.6	97.6	100.9	3.0
SP663465-02 x SP6829-0	84.5 <sup>+</sup>	92.1 <sup>+</sup>	90.6 <sup>-</sup>	100.1	3.3
SL133 x SP6528-01	127.2 <sup>+</sup>	126.9 <sup>+</sup>	102.6	99.5	2.9
SL133 x SP6322-0	93.5	94.9	98.5	100.4	2.9
SL133 x 02 clone	107.2	115.6	97.3	98.8	3.5
SL133 x SP6629-0	122.4 <sup>+</sup>	116.8	104.4	100.9	2.4
SP6721-01 x SP6322-0	106.4	110.1	95.1	100.8	2.3
SP6721-01 x 02 clone	96.7	105.3	94.8	98.8	3.0
SP6423-01 x SP6322-0	102.8	108.3	96.1	99.8	2.9
SP6423-01 x 02 clone	109.4	109.3	98.6	101.4	3.1
SP6423-01 x SP6629-0	77.3 <sup>-</sup>	87.2	89.3 <sup>-</sup>	99.1	3.3
SP64218-01 x SP6322-0	99.0	106.4	95.9	99.1	2.1
SP64218-01 x 02 clone	83.8	90.2	95.0	99.0	2.5
SP64502-01 x SP6528-01	93.8	87.6	106.1 <sup>+</sup>	100.5	2.1
SP64502-01 x 02 clone	108.6	98.9	112.0 <sup>+</sup>	99.6	2.5
(SP65406-01 x SP6442) x SP6322-0	109.3	115.7	96.0	100.1	2.9
(SP6423-01 x EL31) x SP6322-0	100.4	109.6	92.8 <sup>-</sup>	99.3	3.5
(SP6423-01 x EL35) x SP6322-0	94.2	97.7	96.2	101.1	3.4
SP6621-01 x SP6528-01	99.8	102.4	98.8	100.2	3.0
SP6621-01 x SP6629-0	95.6	102.1	93.0 <sup>-</sup>	100.0	1.6
(EL31C2 x SP6121-0) x SP6528-01	113.4	114.1 <sup>+</sup>	99.9	100.3	2.6
(EL31C2 x SP6121-0) x SP6322-0	114.3	128.8 <sup>+</sup>	93.7	98.0	2.3
(SL129 x 133) x SP6322-0	111.7	118.1 <sup>+</sup>	95.8	100.3	3.6
(SP64502-01 x SP6442-0) x SP6322-0	116.6	115.9	104.0 <sup>-</sup>	99.2	2.3
(SP6121-01 x EL31) x SP6322-0	103.8	113.3	93.3 <sup>-</sup>	100.2	2.4
(UI100363 x SP6121-0) x SP6528-01	101.2	106.9 <sup>+</sup>	93.8	100.7	2.9
(UI100363 x SP6121-0) x SP6322-0	117.1	122.5 <sup>+</sup>	95.9	100.5	2.4
(UI100363 x UI2161) x SP6322-0	120.5	124.9 <sup>+</sup>	98.1	100.1	2.9
(UI12163 x SP6121-0) x SP6322-0	100.2	109.9	94.6	99.2	2.3
(FC505 x EL31) x SP6322-0	107.3	115.0 <sup>+</sup>	97.2	98.5	3.0
EL35 x SP6528-01	116.4	117.8 <sup>+</sup>	99.9	99.8	3.0
EL35 x SP6322-0	103.5	106.7 <sup>+</sup>	95.9	101.1	3.0
EL35 x 02 clone	113.0	119.7 <sup>+</sup>	96.1	99.2	3.6
(SP6121-01 x EL35) x SP6322-0	111.7	115.0	97.7	100.2	2.6
(EL31C1 x SP6121-0) x 02 clone	110.9	115.9 <sup>+</sup>	98.7	98.9	3.6
(EL32C2 x EL31) x 02 clone	112.0	122.8 <sup>+</sup>	95.1 <sup>-</sup>	98.8	3.8
(EL32C2 x SP6121-0) x SP6322-0	99.0	110.1	93.1 <sup>-</sup>	99.3	3.1
CV (%)	19.14	15.46	6.10	2.35	
Sm/Gen. Mean (%)	6.77	5.47	2.16	0.83	
LSD 5% pt. (% of SP5822-0)	21.15	17.75	6.30	2.33	

+ Significantly above SP5822-0 at 5% point.

- Significantly below SP5822-0 at 5% point.

(a 0 = No leaf spot, 10 = complete necrosis due to leaf spot

(b Calculated by computer from formula used since 1954

(c Means for SP5822-0 are:

Recoverable sugar	4485 lbs. per acre
Roots	18.3 tons per acre
Sugar	13.35 %
Purity	95.58 %

NORTHERN OHIO SUGAR COMPANY, HEILMAN FARM (cont.)

<u>Variance Table</u>								
Source of Variation	(lbs.) Recov. Sugar (a)		(lbs.) Roots (a)		(% Sugar		(% Purity	
	D.F.	M.S.	D.F.	M.S.	D.F.	M.S.	D.F.	M.S.
Replicates	7	29.147	7	1318.814	7	19.874	7	15.571
Varieties	48	2.005**	48	115.084**	48	2.695**	48	5.319
Random Block Error	327	1.001	331	45.412	333	0.871	330	5.085
Blocks (Elim. Var.)	48	2.470	48	104.902	48	2.321	48	5.418
Component (A)	36	2.670	36	109.411	36	2.652	36	4.972
Component (B)	12	1.871	12	91.377	12	1.328	12	6.756
Intra-Block Error	279	0.747	283	35.321	285	0.627	282	5.028
Total	382	1.642	386	77.168	388	1.440	385	5.304

(a Pounds per plot

\*\* Significant difference among varieties at 1% level

AGRONOMIC EVALUATION TEST, 1969

USDA Varieties

Conducted by: Phil Brimhall, Akio Suzuki, A. W. Erichsen, R. K. Oldemeyer  
and D. L. Sunderland

Location: Old Fort, Ohio

Cooperator: Northern Ohio Sugar Company  
Fremont, Ohio

Date of Planting: April 15, 1969

Date of Harvest: October 15, 1969

Experimental Design: Simple Lattice Design

Size of Plots: 1 row x 25 feet x 8 replications  
28-inch row spacing

Harvest Area/plot: 1 row x 18 feet

Samples for Sucrose and Purity Determinations: 1 sample per plot

Recent Field History: Sugar Beets 1968, spring plowed

Fertilization of Beet Crop: Plow down 100-100-240, Starter 150 lbs 6-24-12

Leaf Spot Exposure: Very severe, readings taken September 9, 1969

Black Root Exposure: Very mild, no loss of stand

Other Diseases: None noted

Soil and Seasonal Conditions: Soil was a sandy loam, moisture was adequate to  
excessive during growing season.

Reliability of Test: Good

Mason City, Iowa USDA Cooperative Test #965-3

by American Crystal Sugar Company

Variety	Gross Sugar	Gross Sugar	Tons Beets	% Sucrose	Impurity Index
	Lbs/A	- KSL*	/A		
(100363 x UI 2161) x SP 6528-01	5071	4551	16.09	15.75	687
SP 6721-01 x SP 6322-0	4688	4157	14.88	15.73	761
SP 6423-01 x SP 6322-0	5303	4720	16.83	15.74	735
SP 64218-01 x SP6322-0	4735	4229	14.84	15.97	710
(EL 31c2 x SP 6121-0) x SP 6322-0	5145	4627	16.31	15.77	677
(12163 x SP 6121-0) x SP 6322-0	4959	4443	15.89	15.60	693
(100363 x SP 6121-0) x SP 6322-0	5169	4615	16.41	15.75	723
(SP 6121-01 x EL 31) x SP 6322-0	4883	4385	15.48	15.77	682
(100363 x UI 2161) x SP 6322-0	5336	4793	16.46	16.20	679
SP 64218-01 x 02 Clone	4360	3913	13.30	16.40	684
(EL 31c2 x SP 6121-0) x 02 Clone	4795	4275	14.90	16.12	722
SL(129 x 133) x SP 6322-0 (Am #2 Hybrid "B")	5229	4706	16.31	16.04	668
General Mean	4973	4451	15.64	15.90	701
LSD (.05)	510	451	1.55	.41	64
F. Value	2.63	2.80	3.37	2.74	1.57
C. V. %	8.87	8.76	8.57	2.25	7.90

\* Minus Known Sugar Loss.

Variance Table

Source of Variation	D/F	Gross Sugar		Tons Beets/A		% Sucrose		Impurity Index
		- KSL						
Replications	5	1,083,095	1,193,840	8.8240	1.5829	56,859		
Varieties	11	511,278	426,830	6.0592	.3515	4,841		
Error	55	194,429	152,193	1.7986	.1283	3,074		
Total	71							

Design: Randomized Block, 6 replications, 12 entries.

Plot Size: 2 rows, 35 feet long, 22 inch rows.

Planted: May 14, 1969

Harvested: September 18, 1969



# East Grand Forks, Minnesota USDA Cooperative Test #985-5

by American Crystal Sugar Company

Variety	Gross		Sugar		Tons		Impurity	
	Lbs/A	Sugar	- KSL*	Beets	/A	Sucrose	Index	
(100363 x UI 2161) x SP 6528-01	5225	3	4696	19.00		13.77	676	
SP 6721-01 x SP 6322-0	4713		4169	17.41		13.55	771	
SP 6423-01 x SP 6322-0	4874		4307	17.91		13.60	776	
SP 64218-01 x SP 6322-0	4455		3946	16.28		13.70	762	
(EL 31c2 x SP 6121-0) x SP 6322-0	4746		4220	17.94		13.23	738	
(12163 x SP 6121-0) x SP 6322-0	5040		4494	18.50		13.62	723	
(100363 x SP 6121-0) x SP 6322-0	5011		4470	18.70		13.40	721	
(SP 6121-01 x EL 31) x SP 6322-0	4793		4258	18.23		13.14	743	
(100363 x UI 2161) x SP 6322-0	5388		4806	19.63		13.73	719	
SP 64218-01 x O2 Clone	4317		3847	15.08		14.32	728	
(EL 31c2 x SP 6121-0) x O2 Clone	4882		4329	17.70		13.79	755	
SL (129 x 133) x SP 6322-0 (Am #2 Hybrid "B")	5548		4991	19.82		14.00	669	
General Mean	4916		4378	18.02		13.65	732	
LSD (.05)	252		228	.88		.39	64	
F. Value	16.09		17.38	18.35		5.48	2.22	
C. V. %	4.44		4.51	4.24		2.45	7.56	
*-Known Sugar Loss								

Variance Table						
Source of Variation	D/F	Gross		Tons		Impurity Index
		Sugar	Sugar	Beets/A	Sucrose	
			- KSL			
Replications	5	129,403	179,772	2.2077	.5047	27,388
Varieties	11	765,054	676,878	10.7337	.6126	6,810
Error	55	47,543	38,950	.5850	.1118	3,064
Total	71					

Design: Randomized Block, 6 replications, 12 entries.  
 Plot Size: 2 rows, 35 feet long, 22 inch rows.  
 Planted: May 20, 1969  
 Harvested: September 26, 1969

VARIETY TEST

1969

FARGO, NORTH DAKOTA

USDA III

AGRICULTURAL RESEARCH DEPARTMENT, HOLLY SUGAR CORPORATION

ZIMMERMAN

CMS	"0"	Pollinator	Acre Gross Sugar	Yield Tons Beets	Percent Sucrose	Beets /100'	% Bolt.	Curly Top	L. Res.
SP6423-01	SP663465-0	SP6322-0	5210	18.04	14.40	118	0.3	0.	3.
SP6423-01		SP65331-3	4918	17.00	14.48	132	0.3	0.	3.
UI2161	SP663465-0	SP6322-0	4886	16.39	15.00	136	0.7	0.	3.
SP67555-01		SP6322-0	4882	16.40	14.96	134	3.7	0.	2.
UI100363	SP663465-0	SP6322-0	4822	15.87	15.26	134	0.3	0.	3.
SP6642-01	SP663465-0	SP6322-0	4766	16.19	14.77	133	0.3	0.	3.
SP6540-01	SP663465-0	SP6322-0	4760	16.71	14.22	134	0.7	0.	3.
SP66350-01		SP6322-0	4753	16.54	14.39	138	2.9	0.	3.
SP6621-01	SP663465-0	SP6322-0	4641	16.00	14.50	127	0.4	0.	3.
SP6721-01		SP6322-0	4528	15.64	14.51	127	1.4	0.	2.
SP65406-01	SP6442-0	SP6322-0	4514	15.04	14.99	133	4.7	0.	3.
SP663465-02		SP6829-0	4512	15.67	14.44	128	0.	0.	3.
SP67189-01		F <sub>3</sub> mm line	4503	15.89	14.14	132	0.7	0.	2.
SP66406-01	SP663465-0	SP6322-0	4380	15.19	14.48	133	0.	0.	3.
SP6423-01		SP6828-01+02	4170	14.37	14.57	119	1.5	0.	3.
SP663465-02		SP6828-01+02	4127	14.19	14.54	122	0.	0.	2.
UI1861	SP663465-0	SP6322-0	4039	13.78	14.67	132	0.	0.	3.
SP6643-027	SP663465-0	SP6322-0	4013	13.68	14.68	130	1.8	0.	3.
SP6621-01		SP65783-3	3860	13.78	14.00	116	0.	0.	3.
SP6621-01		SP6828-01+02	3405	12.02	14.16	114	0.8	0.	2.
GRAND MEAN			4526.30	15.60	14.53	128	0.01	0.	3.
COEFFICIENT OF VARIATION			17.79	18.06	4.80				
STANDARD ERROR OF THE MEAN			268.43	0.94	0.23				
LEAST SIGNIFICANT DIFFERENCE			747.84	2.62	0.65				

## VARIETY TEST

1969

FARGO, NORTH DAKOTA

USDA IV

AGRICULTURAL RESEARCH DEPARTMENT, HOLLY SUGAR CORPORATION

ZIMMERMAN

CMS	"0"	Pollinator	Acre Gross Sugar	Yield Tons Beets	Percent Sucrose	Beets /100'	% Bolt.	Curly Top	L.S. Res.
SP6423-01	UI4661	02 clone(4n)	5378	18.76	14.42	123	0.	0.	3.0
SP6423-01		SP6322-0	5198	18.28	14.23	123	0.4	0.	3.0
SP6423-01	SP6621-0	02 clone(4n)	5163	17.44	14.81	112	0.	0.	2.0
SP673465-01		SP6322-0	5144	17.74	14.59	128	0.	0.	3.0
UI100363	UI2161	SP6322-0	5063	17.17	14.77	130	1.7	0.	3.0
UI2161	SP6621-0	02 clone(4n)	5063	18.06	14.06	120	0.	0.	3.5
SP6423-01		02 clone	4927	17.30	14.24	114	0.	0.	3.0
UI12163		02 clone	4916	16.16	15.23	113	1.6	0.	4.0
EL31C2	SP6121-0	SP6423-0	4900	16.52	14.86	122	0.	0.	3.0
EL31C2	SP6121-0	SP6322-0	4895	17.08	14.35	145	4.1	0.	2.5
EL31C2	SP6121-0	02 clone	4883	16.50	14.82	132	4.0	0.	3.0
UI12163		SP6322-0	4812	15.89	15.15	123	0.7	0.	2.5
SP6121-01	EL31	SP6423-0	4789	16.54	14.49	130	0.	0.	3.0
SP6121-01	UI12163	SP6423-0	4784	16.24	14.74	124	0.	0.	3.5
SP6121-01	UI12163	02 clone	4774	16.27	14.66	135	3.6	0.	2.5
SP6721-01		SP6322-0	4757	15.97	14.92	131	1.7	0.	2.5
UI2161	UI4661	02 clone(4n)	4740	16.36	14.50	116	0.	0.	3.0
SP6121-01	UI12163	SP6322-0	4676	16.36	14.31	129	1.0	0.	2.5
SP6721-01		02 clone	4635	15.94	14.54	135	1.7	0.	3.0
UI100363		SP6528-01	4611	15.48	14.92	134	0.	0.	2.5
UI100363		SP6322-0	4572	15.32	14.96	131	0.3	0.	3.0
UI100363	SP6121-0	SP6423-0	4564	15.41	14.79	128	0.	0.	3.5
SP6121-01	EL31	SP6322-0	4532	15.76	14.42	116	1.6	0.	2.0
UI1861		SP6322-0	4499	15.07	14.90	136	0.	0.	3.5
SP673465-01		SP6528-01	4481	15.00	14.98	131	1.7	0.	2.5
UI100363	UI2161	SP6528-01	4437	15.37	14.49	132	0.	0.	3.0
UI1861		02 clone	4435	14.38	15.39	135	0.	0.	3.5
EL31C2	SP6121-0	SP6528-01	4419	15.10	14.71	123	4.2	0.	2.5
SP6121-01	EL31	02 clone	4364	15.40	14.17	133	6.1	0.	3.0
UI100363	SP6121-0	SP6322-0	4357	15.16	14.38	128	2.1	0.	3.0
SP673465-01		02 clone	4348	14.57	14.98	129	0.3	0.	3.0
UI100363	SP6121-0	02 clone	4332	15.11	14.31	128	2.1	0.	3.0
UI100363	UI2161	02 clone	4330	14.47	15.04	126	0.	0.	3.5
UI100363	SP6121-0	SP6528-01	4325	15.02	14.39	132	1.0	0.	3.5
UI1861		SP6528-01	4278	14.76	14.53	136	0.3	0.	3.0
UI100363	UI2161	SP6423-0	4245	14.24	14.94	126	0.	0.	3.5
SP6121-01	EL31	SP673465-0	4223	14.75	14.35	121	0.8	0.	3.5
UI100363	UI2161	SP6721-0	4164	14.22	14.64	130	0.3	0.	4.0
SP64218-01		02 clone	4054	12.90	15.74	125	5.0	0.	3.0
SP64218-01		SP6322-0	4037	13.64	14.82	132	0.3	0.	3.0
SP673465-01		CT7	3957	12.73	15.59	127	0.	0.	4.0
UI100363		02 clone	3894	13.27	14.76	184	0.	0.	3.5
UI100363	UI2161	SP673465-0	3820	13.32	14.46	112	0.	0.	3.0
SP6121-01	UI12163	SP673465-0	3820	12.94	14.84	112	1.3	0.	3.5
UI100363	UI2161	CT7	3728	12.35	15.08	124	0.	0.	4.0
EL31C2	SP6121-0	SP673465-0	3646	12.78	14.32	113	0.	0.	3.0
SP64218-01		CT7	3524	11.25	15.74	121	0.8	0.	3.0
UI100363	SP6121-0	CT7	3447	11.82	14.63	123	0.	0.	4.0
UI100363		CT7	3249	10.37	15.70	131	0.3	0.	4.0
SP6121-01	EL31	SP6721-0	3237	11.37	14.28	120	1.2	0.	3.0
UI1861		CT7	3226	10.19	15.81	136	0.	0.	4.0
SP6121-01	UI12163	SP6721-0	3206	11.23	14.24	124	0.	0.	3.0
UI100363	SP6121-0	SP673465-0	3177	10.88	14.68	106	0.	0.	3.0
UI100363	SP6121-0	SP6721-0	2585	8.90	14.48	112	0.	0.	3.5
GRAND MEAN			4343.63	14.81	14.72	127		0.	3.18
COEFFICIENT OF VARIATION			15.39	15.79	4.98				
STANDARD ERROR OF THE MEAN			222.77	0.78	0.24				
LEAST SIGNIFICANT DIFFERENCE			617.50	2.16	0.68				

VARIETY TEST

1969

FARGO, NORTH DAKOTA

USDA V

AGRICULTURAL RESEARCH DEPARTMENT, HOLLY SUGAR CORPORATION

ZIMMERMAN

CMS	"0"	Pollinator	Acre Gross Sugar	Yield Tons Beets	Percent Sucrose	Beets /100'	% Bolt.	Curly Top	L.S. Res.
SP65406-01	SP6442	SP6322-0	5387	17.86	15.07	128	2.8	0.	3.0
SP6423-01	EL31	SP6322-0	5317	17.72	15.01	127	1.4	0.	3.0
EL35C2		SP6528-01	5306	17.63	15.06	123	1.5	0.	3.0
SP663465-01		SP6322-0	5268	17.74	14.87	122	1.8	0.	3.0
EL35C2		SP6322-0	5197	17.61	14.73	124	0.4	0.	2.5
SP6423-01	EL35	SP6322-0	5158	17.76	14.49	124	1.1	0.	2.0
SP65406-01	SP643465-0	02 clone	4997	16.42	15.23	127	0.	0.	3.0
EL35C2		02 clone	4969	16.03	15.49	133	1.3	0.	3.0
FC505	EL31	SP6322-0	4965	16.16	15.37	119	1.5	0.	3.0
SP6423-01		SP6322-0	4870	17.38	13.99	114	0.	0.	2.5
EL32C2	EL31	02 clone	4869	16.40	14.78	129	3.1	0.	3.0
SP6423-01	EL35	02 clone	4783	15.73	15.21	130	0.	0.	3.0
SL129	SL133	SP6322-0	4735	15.41	15.37	128	0.	0.	2.5
SP6121-01	EL35	SP6322-0	4719	16.08	14.64	130	1.0	0.	3.0
EL32C2	SP6121-0	SP6322-0	4710	16.39	14.38	116	0.8	0.	2.0
SP6621-01		SP6322-0	4665	15.82	14.77	125	3.6	0.	2.0
SL133		SP6528-01	4653	15.26	15.22	111	1.2	0.	3.0
SL129	SL133	02 clone	4629	14.58	15.87	133	0.	0.	3.0
SL129	SL133	SP6528-01	4619	15.29	15.07	131	0.	0.	3.0
SP663465-01		02 clone	4585	14.81	15.48	132	0.7	0.	3.0
EL31C1	SP6121-0	02 clone	4569	15.06	15.18	127	1.8	0.	3.0
SP64502-01	SP643465-0	SP6322-0	4564	15.04	15.16	127	0.7	0.	3.0
SP64502-01	SP643465-0	02 clone	4562	14.77	15.48	123	5.1	0.	3.0
SP6423-01		02 clone	4551	15.56	14.66	113	0.4	0.	3.0
SP64502-01	SP6442	SP6322-0	4486	15.14	14.81	111	4.4	0.	2.5
SL133		02 clone	4484	14.95	15.06	129	0.7	0.	3.0
SP65406-01	SP6442	SP6322-0	4472	14.99	14.97	128	2.1	0.	3.0
FC505	EL31	02 clone	4411	14.93	14.83	113	0.	0.	3.0
SP65406-01	SP643465-0	SP6322-0	4386	14.94	14.67	127	0.7	0.	3.0
SP6423-01	EL31	02 clone	4314	14.15	15.27	132	1.4	0.	3.0
SP6621-01		02 clone	4296	14.78	14.51	132	2.4	0.	3.0
SP6621-01		SP6528-01	4294	14.69	14.64	101	3.2	0.	2.5
SP6423-01		SP6629-0	4063	13.87	14.62	115	0.	0.	2.5
SP64502-01	SP6442	02 clone	4055	13.40	15.13	124	4.7	0.	3.0
SP64502-01		02 clone	3993	12.76	15.68	109	2.0	0.	3.0
SP64502-01		SP6528-01	3971	13.24	15.01	112	2.8	0.	2.0
SL133		SP6322-0	3875	12.71	15.24	121	0.4	0.	3.0
SP6621-01		SP6629-0	3855	13.35	14.37	100	3.0	0.	2.0
FC505		SP6629-0	3659	12.32	14.82	103	0.5	0.	2.5
GRAND MEAN			4558.65	15.31	14.92	122	0.01	0.	2.8
COEFFICIENT OF VARIATION			14.47	14.48	3.94				
STANDARD ERROR OF THE MEAN			220.34	0.74	0.20				
LEAST SIGNIFICANT DIFFERENCE			613.87	2.06	0.55				



VARIETY TEST

1969

HEREFORD, TEXAS

USDA II

AGRICULTURAL RESEARCH DEPARTMENT, HOLLY SUGAR CORPORATION

REINAURER

CMS	"0"	Pollinator	Acre Gross Sugar	Yield Tons Beets	Percent Sucrose	Beets /100'	% Bolt.	Curly Top	L.S. Res.
UI12163		02 clone	5956	30.69	9.70	149	0.	4.0	3.0
SL129	SL133	02 clone	5930	29.21	10.17	156	0.	3.5	3.5
UI1861		02 clone	5830	28.39	10.29	162	0.	3.5	3.0
SL129	SL133	SP6322-0	5747	30.47	9.39	152	0.	4.0	3.0
SP64218-01		CT7	5707	24.35	11.72	164	0.	4.5	2.5
SL133		02 clone	5687	29.26	9.74	147	0.	5.5	3.0
UI100363		SP6528-01	5641	27.76	10.16	160	0.	3.5	2.5
UI100363		SP6322-0	5640	29.13	9.62	155	0.	4.5	3.0
UI100363	UI2161	02 clone	5586	28.85	9.64	166	0.	3.5	3.5
UI2161	UI4661	02 clone(4n)	5559	30.18	9.21	162	0.	4.5	2.5
UI12163		SP6322-0	5555	28.65	9.76	150	0.	4.0	3.0
SP6423-01	SP6621-0	02 clone(4n)	5544	29.95	9.26	148	0.	5.5	3.0
SP6423-01	UI4661	02 clone(4n)	5481	28.24	9.68	140	0.	3.5	3.5
UI100363		02 clone	5391	27.16	9.89	166	0.	3.5	4.0
UI100363	UI2161	SP6322-0	5360	28.84	9.28	164	0.	5.0	2.5
SL129	SL133	SP6528-01	5281	26.80	9.84	158	0.	4.0	3.0
SP6423-01		SP6651-0	5268	27.38	9.60	149	0.	5.0	3.5
UI2161	SP6621-0	02 clone(4n)	5254	28.40	9.26	148	0.	4.0	3.0
UI1861		SP6528-01	5200	26.91	9.61	155	0.	4.0	3.5
UI1861		SP6322-0	5179	27.04	9.59	161	0.	6.5	3.0
SL133		SP6322-0	5054	25.68	9.86	150	0.	3.0	2.5
SL133		SP6528-01	5017	26.83	9.29	154	0.	5.0	3.0
SP65502/2-01		SP654-0	4996	22.21	11.26	157	0.	4.5	2.0
UI100363	UI2161	SP6528-01	4915	24.91	9.93	158	0.	3.5	3.0
SP6423-01		SP654-0	4789	24.49	9.78	152	0.	3.0	3.0
UI100363	UI2161	CT7	4711	22.49	10.43	172	0.	3.0	3.5
SP6621-01		SP654-0	4643	24.04	9.64	152	0.	5.0	2.0
UI100363	UI2161	SP6721-0	4633	24.16	9.58	155	0.	4.5	4.0
UI100363		CT7	4617	22.77	10.16	148	0.	2.0	4.0
SP673465-01		CT7	4452	23.04	9.67	157	0.	3.0	4.0
SP663465-02		SP6651-0	4403	26.58	8.30	168	0.	4.5	3.0
UI100363	UI2161	SP6423-0	4392	23.31	9.28	139	0.	5.5	4.0
SP663465-02		SP654-0	3983	25.16	7.85	153	0.	3.5	2.5
UI1861		CT7	3471	17.17	10.06	171	0.	3.0	4.5
UI100363	UI2161	SP673465-0	3270	18.54	8.88	155	0.	3.5	3.0
GRAND MEAN			5054.26	26.24	9.63	156	0.	4.11	3.19
COEFFICIENT OF VARIATION			16.02	13.03	7.88				
STANDARD ERROR OF THE MEAN			269.83	1.14	0.25				
LEAST SIGNIFICANT DIFFERENCE			751.74	3.18	0.70				

BREEDING SUGARBEETS FOR RESISTANCE  
TO BLACK ROOT AND LEAF SPOT

G. E. Coe

Research work at the Plant Industry Station, Beltsville, Md. is directed mainly toward varietal improvement in resistance to diseases important in eastern United States. This program contributes to some varieties listed in Section A and to hybrids evaluated primarily in Michigan and Ohio.

The results reported here primarily deals with techniques which aid in production of lines having improved characteristics.

Improved Technique for Black Root Resistance Screening

Progress in improving black root resistant of sugarbeets had made it difficult to obtain a sufficiently severe black root infection among the more resistant lines with existing techniques to differentiate between them. Research in 1968 indicated that the key to more severe infections was high relative humidity for 3 or 4 days immediately after inoculating the seedlings. This can be effected either by enclosing the plants on the greenhouse bench with polyethylene film or by raising the humidity of the entire greenhouse section. The former method is the most effective, and can be too effective for the degree of resistance exhibited by the present breeding lines. Increasing the humidity of the entire greenhouse has created an environment sufficiently favorable for the black root organism to separate our more resistant breeding lines into categories of good, better, and best. The pattern of infection under these new conditions is proving to be quite interesting. About 5 or 6 days after inoculation, most plants appear to be severely infected, but a few stand up erect showing no signs of infection and appear to be escapes. Most of the severely infected plants die within 2 or 3 weeks. The apparent escapes come down with black root rather slowly, but under these conditions the entire hypocotyl usually exhibits disease symptoms and the vigor of the plant is suppressed to some degree. Another argument against these plants being escapes is the uniformity of the number of "escaped" plants in different replication of a single breeding line.

The more severe black root epidemic now being attained in the greenhouse should permit more efficient selection of resistant sugarbeets lines and individual plants.

Greenhouse Screening of Seedling Populations  
for Leaf Spot Resistance

There has been considerable success in developing a greenhouse test for resistance of sugarbeets to leaf spot. The key to success in this method has been the proper control of humidity and temperature.

In the greenhouse method presently being used, 25 seeds of a variety are planted in each of four 6-inch saucers. Multiple seedlings are singled to 1 seedling per seedball planted. This usually leaves from 22 to 25 plants per saucer. When the plants are in the 4 to 6 leaf stage and are about 4 or 5 inches tall, they are moistened with a fogging nozzle and inoculated with ground, dried, diseased leaves collected from the field test the previous year.

Uniform conditions from saucer to saucer were achieved by covering the test with a polyethylene film. This eliminated air currents causing the variable conditions. The tests were conducted in a controlled temperature room in order to control the temperature variable. Under constant conditions of 80° F. and 95% to 100% relative humidity, all the lines tested took leaf spot rapidly and severely so that lines apparently resistant in field tests appeared little or no more resistant than lines known to be more susceptible. Relative humidity was reduced by punching holes in the top of the polyethylene film. Enough holes were punched so that the relative humidity was reduced to 80%. Under our conditions,  $\frac{1}{4}$  inch holes every  $2\frac{1}{2}$  inches in the top of the sheet resulted in approximately 80% relative humidity under the sheet. Watering the saucers once each day was necessary. We have been doing this with a glass funnel through the holes in the plastic sheet. At a temperature of 80° F. and 80% relative humidity, the plants became infected rather rapidly and severely. Within 10 days after the first spots appeared, all plants were severely diseased. However, differences between lines were readily observable and measurable as the degree of infection increased, but these differences were not as great as differences observed in field tests. For any particular line, there was also the question of whether the resistance exhibited by seedlings would correlate with the observed resistance of more mature plants in the field tests. Correlations between the resistance of seedlings observed in the greenhouse and the resistance of more mature plants observed in the field tests have been improving as the greenhouse technique improved, and are now ranging from  $r = .84$  to  $r = .98$ . It is felt that the technique is now sufficiently reliable to screen breeding lines in the greenhouse, but it is desirable to have more confirming field tests before deciding to eliminate the field test entirely.

#### Selecting Sugarbeets for Quality Improvement

Selection for low content of soluble nonsucrose solids was started in 1956. There was some evidence that variation from spot to spot in the field plot was influencing the content of soluble nonsucrose solids in the roots. The factor immediately suspected was variation in soil fertility. Experiments were run to determine the effect of excess fertilizer on soluble nonsucrose solids and on percent sucrose. The treated plots were given an excess of 215 lbs. of nitrogen, 130 lbs. of phosphorus and 85 lbs. of potassium. Roots harvested from the excess fertilizer plots averaged 1.5 to 2.5 percentage points lower in sugar content than roots harvested from check plots. They averaged from



.1 to .2 percentage points higher in soluble nonsucrose constituents than roots from check plots. The range of % soluble nonsucrose solids among roots is from 1.5 percentage points to 2.25 percentage points depending on the season. It would seem that normal soil variation in nitrogen, phosphorus, and potassium do not have an important influence on percentage of soluble nonsucrose solids. If there is an important plot variation influencing these constituents, it must be something other than the elements tested.

The present breeding lines have a reasonably low content of soluble nonsucrose solids as a result of selections over the past 14 years, but it would be desirable to find a more efficient way to select this characteristic.

#### Breeding for a Globe-Shaped Sugarbeet

When labor shortage stimulated efforts to harvest beets mechanically, Mr. G. W. Deming started breeding beets with a shape similar to garden beets in an effort to facilitate mechanical harvesting. Before these became as productive as existing varieties, mechanical harvest for ordinary spindle-shaped sugarbeets were "perfected", and the need for a globe-shaped sugarbeet ceased to exist. Thus, this work was discontinued. The elimination of all hand labor and as much machine labor as possible is desirable for any crop. Table beets require less labor than sugarbeets. There are several reasons for this, but the most important is the fact that the beets are thicker in the rows. Thinning is not necessary, and because the plants are thick in the row they compete better against weeds. Breeding for globular-shaped sugarbeets has been undertaken again, at Beltsville, in an attempt to make sugarbeets the easiest crop a grower can plant. Regular spacing of seeds will still be a requirement, but thinning operations will be eliminated. If the crop is planted in rows, it is envisioned that a double row 3 inches apart will be planted instead of single rows. The plants in each of the double rows would be spaced about 3 inches apart. The row crop would still have to be cultivated. An experiment was conducted at Beltsville in 1969, spacing sugarbeets 2", 3", 4", 5", 6", 8", and 10" apart in single rows 2 feet apart. Unfortunately, Rhizoctonia disease eliminated many of the plants in the 8" spacing, but all spacings had reduced plant populations at harvest time. There was no hoeing of weeds. The plot was cultivated as needed, and endothal + T.C.A. was used as a preemergence herbicide. The test was preliminary in nature and was not replicated, so that statistical analyses are not possible. Nevertheless, the data are presented in Table I.



Table I. Results of Plant Spacing Test

Plant Spacing At Thinning	No. Plants/100' Row At Thinning	Rt. Yield At Harvest	Tons/Acre	% Sucrose	% Raw Juice Apparent Purity
2"	600	334	12.14	12.0	83.62
3"	400	267	11.16	12.0	81.03
4"	300	220	11.43	11.8	83.92
5"	220	170	9.34	10.8	81.14
6"	200	148	11.79	9.4	78.53
8"	150	92	9.37	11.5	83.21
10"	120	103	11.35	10.0	79.68

Yields were low at Beltsville in 1969, and these results might not agree with results which would be obtained in a more favorable year. From the 1969 data, one would conclude that spacing within the row did not affect root yield, % sucrose, or % purity. General observations of weed populations indicated that there were fewer weeds in the 2", 3", and 4" spacings, and supports the idea that thicker plant populations help control weeds. It has been suggested that the seed might be sown in rows 4 inches apart and spaced 4" apart in the row, thereby, eliminate the need for row cultivation. This would reduce cultural practices to land preparation, herbicide application, planting, beating off the tops, and harvesting.

Mr. Deming's round beets were also planted in the 1969 nursery. They exhibited a wonderful susceptibility to leaf spot and root rotting diseases, and a remarkable inability to compete with the weeds. Several backcrosses to disease resistant varieties will probably be necessary, before globular-shaped beets are adapted to the eastern region.

#### Cercospora Leaf Spot Resistance in 1970 Beltsville Nursery

<u>Variety</u>	<u>Leaf Spot Rating*</u>
SP6822-0 (Resistant Check)	2.00
US 401	4.00
US H20	4.00
SP633269-0 (Susceptible Check)	5.00
Zwannpoly	6.00

\*0 = no spots on leaves; 10 = all leaves dead with leaf spot

No yield data taken. Plants were rather small and unthrifty because of diseases at Beltsville.

Sugarbeet Disease Investigations in the  
Great Lakes Area in 1969

C. L. Schneider

1. Greenhouse screening  
tests for black root  
disease resistance

In a series of 31 inoculation tests, 331 cultivars from the East Lansing Station were tested for resistance to the beet water mold, Aphanomyces cochlioides in accordance with previously described methods. Results of 1969 tests are summarized in Table 1, where disease severity ratings are expressed in percent of the standard comparison variety, U.S. 401. In this series of tests over 78% of the entries were in classes more resistant than variety U.S. 401 and less than 2% were in a class of lower resistance.

2. Studies on Aphanomyces  
cochlioides oospores

Efforts were continued toward development of a growth medium favoring oospore production by A. cochlioides. The fungus was grown for about 30 days in petri plates of agar plus various natural nutrients at several concentrations. Oatmeal at 5 gm. per liter was superior to all other materials tested for oospore production. On this medium over 40 oospores per low power microscope field (96x) were observed. Oospores were produced in lesser amounts on agar with the following nutrients: decoctions of grain kernels, radish roots, sugarbeet roots and leaves; homogenates of radish roots, turnip roots, sugarbeet seedlings and pearl barley. Oospore

TABLE 1.--Distribution of sugarbeet breeding lines according to reaction to Aphanomyces cochlioides in greenhouse inoculation tests in 1969.

Breeding Line Designation	Disease severity classes <sup>1/</sup> and number of lines in each class					Number of lines tested
	30-49	50-69	70-89	90-109	110-129	
G-37	1	22	40	14	1	78
68B6	-	2	16	--	-	18
68B7	-	2	2	--	-	4
68B8	-	4	9	6	-	19
68B9	-	4	16	17	1	38
68B10	-	24	81	41	3	149
68B11	-	4	14	7	-	25
Total	1	62	178	85	5	331

<sup>1/</sup> Disease severity expressed in percent of variety U.S. 401 which = 100. Classes less than 100 are more resistant than U.S. 401; those above 100 are more susceptible.

production was noticeably affected by nutrient concentration. Generally, nutrient levels favoring oospore production were considerably below levels optimum for vegetative growth. However, oatmeal at 5 gm. per liter permits vigorous vegetative growth and a high level of oospore production as well.

Infectivity of dried oospore-containing material has been demonstrated in the greenhouse. Typical symptoms of *Aphanomyces* seedling blight have developed on sugarbeet plants when oospores, ranging in age from 9 days to 2 years were applied in the soil with the seed at planting. A satisfactory medium for production of oospore inoculum in flasks consists of 1 part by volume of homogenized oatmeal broth (5 gm./liter) to 2.5 parts vermiculite. Abundant oospores are produced on this medium after about 30 days growth, then the contents of the flasks are removed; air-dried for several days, and stored in closed containers at about 4°C. Oospore inoculum was also produced by growing the fungus on .5% oatmeal agar plates for about 30 days, then grinding the contents of 5 plates in a blender for one minute (in 250 ml. water), mixing the homogenate with 700 ml. vermiculite and spreading it out on newspaper to dry. The latter method permits measurement and control of the numbers of oospores involved if spore counts of the homogenate are made with a counting chamber or haemocytometer.

In greenhouse studies, seedling disease severity increased with increased dosages of dried oospore inoculum. Inoculum levels of 5-10 ml. per 4 in. pot, applied with the seed have resulted in sufficient infection and disease development to permit differentiation between resistant and susceptible types.

### 3. Studies on *Rhizoctonia* crown and root rot (*Rhizoctonia solani*)

After encouraging results in 1968 of field inoculations with Michigan isolates of *R. solani* for testing



resistance and selecting resistant plants, studies were initiated to determine the feasibility of testing plants for *Rhizoctonia* resistance in the greenhouse. Stecklings of a *Rhizoctonia*-resistant line, developed by J. O. Gaskill and associates and a non-resistant line were inoculated in the crowns with toothpick cultures of R. solani in a manner similar to that described by Schuster et al. (3). Within 60 days differences in disease incidence and severity in the two varieties were discernible (Table 2). These results are regarded as preliminary; tests with additional breeding stocks are needed before the feasibility of a greenhouse testing program can be determined.

In developing a methodology for inducing *Rhizoctonia* crown rot in the greenhouse it was noted that disease incidence and severity were noticeably increased when soil (100 ml.) was applied in the crowns of plants after they had been inoculated by the toothpick method (Table 3). The results suggest that the throwing of soil in the crowns, practiced by some growers in cultivating operations, may lead to increased incidence of crown rot if conditions are favorable.

Studies on physiologic specialization among sugarbeet isolates of *Rhizoctonia solani* were continued. Sixteen plant species, including some common crops grown in rotation with sugarbeet, and some common weeds were inoculated in the greenhouse with Michigan and Ohio isolates of the fungus from sugarbeet roots, crowns, seedlings and foliage, and an isolate from wheat stubble in a sugarbeet field. Pathogenicity on stecklings was determined by placing cultures of the fungus in soil adjacent to plants in pots. Pathogenicity on other hosts was determined by planting seeds above an agar plate culture of the fungus in 4 in. pots in accordance with an inoculation technique described previously (2). The isolates differed in pathogenicity and virulence on several hosts (Table 4). Most of the isolates from sugarbeet attacked all test species and symptoms ranged from mild to severe in intensity. The sugarbeet foliage isolate was more aggressive than other isolates on certain

TABLE 2.--Results of inoculating stocklings of two sugarbeet varieties with Rhizoctonia solani in the greenhouse.

Variety and type	Experiment No.	Number of Plants:		
		Graded <sup>1</sup> "Resistant"	Graded <sup>2</sup> "Susceptible"	Inoculated
SP 671008-0 (Rhizoctonia-resistant)	I	8	13	21
	II	14	8	22
	Total	22	21	43
SP 621220Ho (Rhizoctonia-susceptible)	I	1	24	25
	II	5	17	22
	Total	6	41	47

<sup>1</sup>plants rated "resistant" had either mild symptoms or were symptomless.

<sup>2</sup>plants rated "susceptible" either died or had severe symptoms of crown and root rot.

TABLE 3.--Effect of soil application in crowns of sugarbeet plants in the greenhouse on Rhizoctonia crown and root rot development.

Treatment	Number of Plants:		Root rot <sup>1</sup> severity index
	Infected	Dead	
Soil applied in crowns	33	15	2.72
None--control	28	9	1.68

<sup>1</sup>Average severity index computed after assigning each plant a numerical rating from 0 (no symptoms) to 4 (dead).

TABLE 4.--Pathogenic capabilities of Rhizoctonia solani isolates on several plant hosts in greenhouse inoculations.

Plant host	No. of plants inoculated with each isolate <sup>1</sup>	Source of isolates and range of disease severity ratings caused by the isolates on each host <sup>2</sup>				
		Sugarbeet				Wheat stubble
		Roots and crowns	Seedlings	Foliage		
Sugarbeet stocklings, U.S. 401	5	M-S	O-I	M		O
Sugarbeet seedlings, U.S.H-20	62	M-S	M-S	S		S
Amaranthus retroflexus	53	M	M	M		M
Chenopodium album	40	M	M-I	M		M
Wheat--Monan	44	O-M	O-M	M		O
Oats--Coachman	44	O-M	O-M	M		M
Turnip--Purple Top	57	M-I	M	I		M
Sweetclover--Yellow Blossom	19	O-M	O-M	M		M
Cucumber--Fancy Pickling	30	M	M	S		M
Cabbage--Wisc. Hollander	41	M-S	M-S	S		S
Tomato--Rutgers	36	O-M	O	M		M
Sunflower--Mammoth Russian	17	O-M	O-M	I		O
Pepper--Calif. Wonder	32	O-M	O-M	S		I
Soybean--Chippewa	17	O-I	M	S		M
Navy bean--Great Northern	18	I-S	I-S	S		S
Number of isolates tested	11	3	1	1		1

<sup>1</sup>Based on stands in uninoculated controls.

<sup>2</sup>Severity ratings: O = no symptoms; M = mild (av. numerical ratings up to 1.5); I = intermediate (numerical ratings between 1.6-2.5); S = severe (numerical ratings between 2.6 and 4.0).



hosts, such as cucumber, pepper, soybean, and sunflower but was not pathogenic on older sugarbeets. The isolate from wheat stubble attacked several hosts, including sugarbeet seedlings, but did not attack older sugarbeets. The isolates also differed in morphology and growth rate on nutrient agar.

#### 4. Disease survey-- Ferden Farm

The crop sequence study conducted by Crop and Soil Science Department, Michigan State University, affords a unique opportunity for field study of effects of certain cropping systems and fertilizer practices on the natural occurrence of sugarbeet diseases. The plots are located on the Ferden farm in Saginaw County, Michigan. The seven 5-year rotations and the fertilizer program have been previously described (1). During the 1969 season, the sugarbeet plots were surveyed to determine disease occurrence. Estimates of foliage vigor, obtained with L. S. Robertson on July 1, and stand counts of plants on September 9 were considerably lower in plots of cropping sequence #2, where sugarbeets follow alfalfa (Table 5). Evidence of a general occurrence of black root disease in the sugarbeet plots indicates that the depressed stands and vigor ratings were probably due to the activity of disease fungi such as Aphanomyces cochlioides and Pythium spp. that are favored by the extremely wet soil conditions that prevailed. Incidence of Rhizoctonia crown and root rot and other diseases was comparatively low and there were no appreciable differences in incidence of these diseases due to cropping sequence. Fertilizer level did not appear to affect incidence of any disease in 1969.

#### 5. Fungicide tests

Following is a progress report on the current status of research on pest control. It does not contain

TABLE 5 Effect of crop sequence on disease incidence in sugarbeet plots in Ferden Farm Test, 1969.

Crop Sequence Number and Previous crops	Early $\frac{1}{2}/\frac{3}{3}/$ Foliage Vigor Rating	No. Plants Per 100 Ft. of row $\frac{1}{3}/$	Total number of plants with symptoms of the following <sup>4/</sup> diseases:			
			Rhizoctonia crown rot	Savoy leaf virus	Yellow <sup>5/</sup> virus	Other root rot
1 - corn	3.3 bcd	94.5 a	6	2	0	0
2 - alfalfa	2.8 d	74.1 b	16	3	0	3
3 - beans	3.0 cd	82.7 ab	16	5	1	0
4 - corn	3.8 abc	87.4 ab	6	5	3	0
5 - corn	4.3 a	89.8 ab	15	2	2	6
6 - corn	4.0 ab	82.4 ab	22	4	0	0
7 - corn	3.8 abc	89.1 ab	32	1	3	0

- 1/ Results expressed as means of 4 replicated plots, each comprising 6 rows 90 ft. long.
- 2/ Ratings vary from 1 to 5 in order of increasing vigor.
- 3/ Entries followed by same letter do not differ significantly according to Duncan's multiple range test.
- 4/ Results expressed as totals of 4 main plots (total of 4320 ft. of row).
- 5/ Symptoms typical of Beet Western Yellows but occurrence of virus was not proven by bioassay.

recommendations for use of pesticides nor does it imply that the uses discussed have been registered. Mention of a trademark name or a proprietary product does not constitute a guarantee or warranty of the product by the United States Department of Agriculture and does not imply its approval to the exclusion of other products that may also be suitable.

Field tests to determine efficacy of selected fungicides to control diseases common in the Great Lakes area were conducted in cooperation with H. S. Potter, Michigan State University. Variety U.S. H20 was used in all tests. Seed treatments were applied as slurries. Soil treatments were applied as liquid suspensions or as granules in a 10 in. band along the drill row before planting and were worked into the soil with a rotary hoe to a depth of about one inch.

In a test at East Lansing, eleven fungicide treatments were tested in plots naturally infested with the beet water mold, Aphanomyces cochlioides. Disease development was favored by extremely wet soil conditions in late spring and early summer. The treatment with Daconil + Dexon granules gave highest stands at thinning and at harvest (Table 6). Differences in root weight between treatments were not statistically significant.

In a field experiment at East Lansing, 17 chemical treatments were tested for control of Rhizoctonia crown and root rot. Plots were artificially infested with R. solani inoculum after seedlings had emerged. In addition to seed and soil treatments, some treatments included the spraying of certain chemicals in aqueous sprays onto the crowns (100 gal./A) on 6 dates 2 weeks apart commencing on June 11. Only the combination soil and crown spray treatments provided control through harvest. With seven of these treatments, harvest stands and root rot severity ratings were significantly better than untreated controls. In adjacent plots, 6 applications of the following materials to crowns of plants did not significantly reduce disease damage: Dithane M-45 (2 lb./A); Tri Basic Copper Sulfate 53% (4 lb.); Du-Ter

(0.25 lb.). In a grower's field in Gratiot County, Michigan, where a natural epiphytotic of crown rot occurred, crown sprays of the following, applied on July 9 and August 4, did not significantly reduce disease incidence: Dithane M-45 (2 lb./A); Kocide 101 (2 lb.); Polyram (2 lb.); Tri Basic Copper Sulfate (4 lb.); Cal Cop 10 (0.5 gal.).

In research plots artificially infested with Cercospora beticola, 17 materials were tested for ability to control leaf spot disease. All fungicide treatments tested reduced disease severity (Table 9) and there were significant differences between treatments. The effectiveness of spray amendments in prolonging the effectiveness of fungicides was demonstrated.

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Table 6 - Effectiveness of selected fungicides in controlling Aphanomyces cochlioides seedling blight and root rot at East Lansing, Michigan in 1969.

Treatment		Application method	No. plants per plot		Vigor <sup>2/3/5/</sup> rating June 25
Fungicide <sup>1/</sup>	Dosage (active)		June 11	Oct. 8	
			4/		
Busan 72 60EC	1.5 oz/cwt	On seed	68.6 cde	10.2 bc	3.0 cde
Dexon 70W	2.8 "	"	81.2 abc	11.8 bc	3.4 bc
Terraclor Super X W60-15	3.6 "	"	79.0 bc	11.8 bc	3.2 bcd
BAS 3050 F 75W	7.5 lb/A	In soil	52.8 e	10.8 bc	2.4 de
Busan 72 60EC	2.0 "	"	79.0 bc	10.0 bc	3.4 bc
Daconil 2787 75W	1.1 "	"	70.8 cd	7.8 c	3.0 cde
Daconil + Dexon 10-2.5 G.	1.5 "	"	93.0	16.4 a	4.6
Dexon 70W	2.9 "	"	88.2 ab	13.4 ab	4.2 ab
" "	5.8 "	"	81.4 abc	12.0 bc	4.0 ab
TCMBS 40EC	2.0 "	"	61.8 de	10.0 bc	3.0 cde
TCMTOB 90WP	12.0 "	"	71.0 cd	10.4 bc	3.6 abc
None - Control	--	--	78.2 bc	11.8 bc	3.4 bc

<sup>1/</sup> Mention of a trademark or proprietary product does not constitute guarantee or warranty of the product by the U. S. Department of Agriculture and does not imply its approval to the exclusion of other products that may also be suitable.

<sup>2/</sup> Means of five single-row plots, 20 ft. long.

<sup>3/</sup> Entries with same letters do not differ significantly at the 5% level.

<sup>4/</sup> Before thinning.

<sup>5/</sup> Vigor ratings range from 1 (lowest) to 5 (highest).

Table 7 - Effectiveness of selected fungicides in controlling Rhizoctonia solani crown and root rot at East Lansing, Michigan in 1969.

Fungicide <sup>1/</sup>	Treatment		Application method	Plants per plot <sup>3/4/</sup>		Root rot <sup>3/4/</sup> severity <sup>5/</sup> rating			
	Dosage (active)	2/		Oct. 24					
				June 17					
Terracoat L 205	12 oz/cwt		A	18.6	de	5.2	ef	3.2	def
Terraclor Super X W60-15	3.6 "		A	18.0	e	4.0	f	3.3	ef
Vitavax 75W	5.3 "		A	21.0	abcd	5.2	ef	3.4	f
BAS 3050 F 75W	7.5 lb/A		B	15.2	f	5.2	ef	2.7	cdef
Busan 72 60EC	2.0 "		B	19.2	cde	6.4	def	3.1	def
Daconil-Terrazole 10-2.5G.	1.5 "		B	20.4	bcde	5.6	def	3.2	def
TCMBS 40EC	12.0 "		B	20.0	bcde	4.8	ef	3.3	ef
TCMTOB 90W	12.0 "		B	19.0	de	4.2	f	3.2	def
Vitavax 5G	1.2 "		B	20.0	bcd	5.0	ef	2.8	cdef
Benlate 50W	3.1 "		B&C	21.6	abc	16.2	ab	1.3	a
Daconil 75W	1.6 "		B&C	20.2	bcd	9.0	cde	2.6	cde
Terraclor 75W	2.0 "		B&C	21.6	abc	15.0	ab	1.7	ab
"	4.0 "		B&C	22.2	ab	18.6	a	1.2	a
Terraclor Super X W60-15	1.0 "		B&C	21.0	abcd	12.0	bc	2.3	bc
"	2.0 "		B&C	23.4	a	10.2	cd	2.5	cde
Vitavax 75W	1.0 "		B&C	20.0	bcd	6.8	def	3.0	cdef
"	2.0 "		B&C	20.2	bcde	10.2	cd	2.4	bcd
None - Control	---		---	19.2	cd	4.8	ef	3.4	f

<sup>1/</sup> Mention of a trademark or proprietary product does not constitute guarantee or warranty of the product by the U. S. Department of Agriculture and does not imply its approval to the exclusion of other products that may also be suitable.

<sup>2/</sup> A = Seed treatment; B = Soil treatment; C = Sprayed on crowns.

<sup>3/</sup> Mean of 5 single-row plots, 20 ft. long.

<sup>4/</sup> Entries with same letters do not differ significantly at 5% level.

<sup>5/</sup> Root rot severity ratings = 0 (no symptoms); 1 (light); 2 (moderate); 3 (severe); and 4 (dead).

Table 8 - Effectiveness of selected fungicides and additives in controlling Cercospora beticola leaf spot disease at East Lansing, Michigan in 1969.

Fungicide <sup>1/</sup>	Lb/A/100 gal (active)	Additive <sup>2/</sup>	Frequency (days)	Disease <sup>3/</sup> severity <sup>4/</sup> rating <sup>5/</sup>
Benlate 50W	0.50	--	14	0.9 a
Cal Cop-10 LC 10% Cu.	0.47	--	14	3.8 d
" " " "	0.47	Pinolene	21	4.0 d
Daconil 75W	1.50	--	14	3.4 cd
Dithane M-45 80W	1.60	--	14	3.3 cd
" " " "	1.60	Pinolene	21	3.4 cd
" " " "	1.60	--	21	4.0 d
Du-ter 50W	0.67	--	14	3.0 c
FT 2-A 13.8% Cu.	7.25	--	14	4.0 d
" " " "	14.50	--	21	3.4 d
Kocide 101 56W	1.68	--	14	2.9 c
" " "	1.12	Oil	14	3.0 c
" " "	1.12	Pinolene	21	3.8 d
" " "	1.12	Oil	21	3.8 d
Mertect 160 60W	0.31	--	14	3.0 c
" " "	0.62	--	14	2.1 b
TCMTOB 90W	2.20	--	14	3.8 d
Non - Control	--	--	--	4.8 e

<sup>1/</sup> Mention of a trademark or proprietary product does not constitute guarantee or warranty of the product by the U. S. Department of Agriculture and does not imply its approval to the exclusion of other products that may also be suitable.

<sup>2/</sup> Applied one qt/A.

<sup>3/</sup> Rating = 0 (no symptoms) to 9 (complete defoliation).

<sup>4/</sup> Means of four plots, each comprising two 20 ft. rows.

<sup>5/</sup> Entries with same letters do not differ significantly at 5% level.

## PHYSIOLOGICAL INVESTIGATIONS - 1969

F. W. Snyder

### Germination Studies

The objective of this study was to relate date of harvest and fruit moisture content at harvest to germination performance of sugarbeet seeds. Six mother roots of six cultivars were taken from the field, potted, and then induced to produce seed in the greenhouse. Moisture content of the fruits at first harvest ranged from about 360% to 225% air dry basis or about 74% to 81% wet basis. Samples of fruits were harvested at approximately 4-day intervals thereafter. The fruits were air dried in the laboratory and then hand-processed to remove as much of the corky material as possible. For a given plant, samples of fruits from each harvest were placed on the same blotter (double thickness). Three replications were used. The date at which the harvested fruits appeared to be commercially ripe was closely estimated for each plant. The criterion for "good germination" in 10 days was set at 90% or higher.

With the exception of seeds of three plants of one cultivar, the seeds attained "good germination" at some given moisture content and maintained it through the final harvest. Of the three exceptions, two plants died before the seeds fully matured, but the third plant grew normally.

For different plants, "good germination" first occurred 35 to 70 days after first bloom or when the moisture content of the fruits at harvest was as low as 22% to as high as 236% (approx 29% to 74% moisture content wet basis). The average moisture content for individual cultivars ranged from 101% to 169%. Germination averaged 90% for all the plants when the average moisture content of the fruits was between 130% and 140% (approx 62% to 66% wet basis).

The surprisingly large plant to plant variation within a given cultivar appears to be more strongly related to genetic differences than to any possible environmental differences.

Data from all the plants indicate that the physiological maturity of the seeds does not coincide with a specific moisture content of the fruit. Apparently plants can be selected which produce physiologically mature seeds at relatively high fruit moisture. This characteristic would provide greater leeway in time of harvesting without an adverse effect on germination. Earlier harvest at the higher fruit moisture may also interrupt the normal abscissional processes and thereby reduce the loss of fruits by shattering during the harvest operation.

### Leaf Area Accretion Studies

The general role of leaf area to plant yield is well known. However, many of the more specific aspects as related to sugarbeets have not been studied in detail. Earlier studies have indicated that plants differ in the rate



of accreting leaf area and that for individual plants root weight and leaf area may correlate poorly.

Studies in growth chambers are being directed toward determining 1) the effect of light and temperature on the rate of leaf area accretion; 2) how uniformly plants of a cultivar accrete leaf area and how greatly cultivars differ; 3) if the early rate of accreting leaf area is closely related to final root yield; and 4) if certain chemicals applied to foliage of young plants will accelerate leaf area accretion. Insufficient data preclude a report.

#### Translocation Studies

The study reported on page E30 in Sugarbeet Research, 1968 Report has been continued. The procedures were unchanged, except that leaves were swabbed 9 times at 10-min intervals. Additional replications were completed for kinetin (Ki), gibberellic acid (GA), and indole 3-acetic acid (IAA), including some using GA at  $2.25 \times 10^{-3}$  and IAA at  $3.0 \times 10^{-4}$  M. The data for N-6 benzyladenine (BA) will be included in the summary below.

<u>Chemical</u>	<u>Effect on translocation</u>	<u>Percent of control</u>
BA	Retard - strong trend	92.1
Kinetin	Retard - significant 5%	92.0
GA	None	
IAA	None	

The additional data for GA failed to support the trends indicated in the preliminary data included in the 1968 Report.

The following compounds, reported to increase sugar accumulation in either sugarbeet or sugarcane: catechol, hydrothol 191 (H-191), and vanadyl sulfate (VS), were used on sugarbeets.

Catechol (0.02 M) severely damaged the leaves. Four replications of 0.005 M and seven of 0.002 M concentration did not give any consistent data.

H-191 at 150 ppm was toxic. Four replications of 50 ppm on plants having adequate nitrogen and on plants deficient in nitrogen consistently averaged below the control, thus suggesting some retardation. H-191 (15 ppm) was applied to six plants of each nitrogen status. Although the stimulation of the +N plants was not statistically significant, the average translocation was 14.7% greater and 5 of the 6 plants were stimulated. In contrast, H-191 slightly retarded translocation in nitrogen deficient plants and more plants were retarded than stimulated. The results with the +N plants suggest that additional testing may be warranted.

VS was applied at 0.02 and 0.002 M concentrations to 6 plants of each nitrogen status. The leaves treated with 0.02 M VS had only 83.5% of the radioactivity per  $\text{cm}^2$  of blade found in the control leaves. Nevertheless, the uncorrected raw data indicated that VS increased translocation 6.2% for +N plants. If correcting the translocation into the petiole by an amount equal

to the reduced activity in the blade is valid, then VS stimulated translocation 26.4% (not quite significant at 5%). Again 5 of 6 +N plants were stimulated. VS had little effect on translocation in nitrogen deficient plants. VS at 0.002 M concentration had no consistent effect on translocation in plants of either nitrogen status.

The reduced incorporation of  $^{14}\text{C}$  in leaves treated with VS suggested that either VS affected stomatal aperture or actual incorporation of  $\text{CO}_2$ . Imprints of portions of the surface of control and treated leaves were examined. Precisely how rapidly VS induces a change in stomatal aperture was not established clearly, but the 0.02 M treatment decreased the stomatal aperture 20 to 38% during the period from 24 to 72 hours. VA at 0.005 and 0.002 M concentrations had little effect on stomatal aperture.

The technique will be modified in an attempt to reduce variability and permit more definitive data. Since at least 2 of the chemicals tested tended to stimulate translocation in +N plants, but not in nitrogen deficient plants, further investigation is planned to identify the effects more clearly.

Physiological Studies on Sugarbeets<sup>1/</sup>

R. M. Cressman<sup>2/</sup>

Histological Distribution of Sugar in the Sugarbeet

Histological distribution of sugar in sugarbeets has been examined by two methods. Concentrations of sugar in each vascular ring and in each interzonal band of parenchyma were determined chemically and distribution within the tissues was examined histologically.

For the chemical analyses, a radial segment of tissue, several millimeters thick and 5 to 10 mm. wide was cut from a slice of sugarbeet. This segment was then divided into the core, the individual rings, and the bands of interzonal parenchyma (hereafter called interzones). The pieces were weighed, the sugar extracted by boiling, and, after appropriate dilutions, the sugar was analyzed by the phenol-sulfuric acid procedure (1, 2).

A section of beet adjacent to this radial segment was sectioned on a hand microtome and the sections processed as described in my 1968 report (Sugarbeet Research, 1968 Report, p. E31) to precipitate the sugar within the cells. The sections were then examined under a dissecting microscope.

Table 1 lists the sugar concentrations found in various rings and interzones. The concentrations in the rings of a particular segment are relatively constant except for the lower concentration in the outermost, immature ones. Concentrations in the interzones are somewhat lower than those in the rings in the interior of the beet but increase progressively toward the exterior.

The histological examinations generally corroborated the chemical analyses. Estimates of the sugar content relative to the potential capacity usually paralleled the analyses, but could not be made with a great deal of precision.

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<sup>1/</sup> This research was conducted in cooperation with the Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota.

<sup>2/</sup> Plant Physiologist, United States Department of Agriculture, Agricultural Research Service, Fargo, North Dakota.

Table 1. Sugar concentrations in the rings and interzones of sugarbeets.  
C = central core, I = interzone, R = vascular ring.

Zone	Percent sugar										Zone	
	Beet	Av.:	16.2	15.1	14.6	13.7	11.7	11.7	11.4	11.2	9.9	Av.
C												
I-1	16.8	15.7	15.7	15.7	14.4	14.4	13.1	11.8	11.9	12.7	10.9	13.7
R-1	14.5	12.2	10.4	10.4	10.9	10.9	8.3	11.0	8.4	8.5	7.9	10.2
I-2	16.9	16.5	15.7	15.7	13.8	13.8	13.5	12.8	12.9	12.4	10.0	13.8
R-2	15.7	13.4	11.4	11.4	11.4	11.4	8.9	11.3	8.7	8.4	8.3	10.8
I-3	16.8	15.9	15.5	15.5	14.0	14.0	12.9	13.1	12.0	11.8	10.9	13.7
R-3	15.2	14.8	11.6	11.6	12.0	12.0	8.6	11.6	7.4	9.2	8.8	11.0
I-4	16.5	16.4	16.0	16.0	14.3	14.3	12.4	12.2	12.3	12.9	9.9	13.7
R-4	16.3	16.1	12.5	12.5	12.8	12.8	9.6	11.6	8.9	9.3	8.6	11.7
I-5	16.5	15.8	15.8	15.8	14.4	14.4	13.0	12.4	12.5	11.0	10.2	13.5
R-5	16.7	16.4	13.2	13.2	13.2	13.2	11.1	13.3	10.2	9.4	10.0	12.6
I-6	16.5	15.5	15.9	15.9	14.5	14.5	13.6	12.5	12.5	12.0	10.9	13.8
R-6	17.3	-	14.7	14.7	13.9	13.9	12.2	12.9	12.0	11.8	11.1	13.2
I-7	16.4	15.7	16.1	16.1	15.1	15.1	14.2	12.9	13.6	12.5	11.6	
R-7			15.7	15.7	14.6	14.6	13.5	12.7	13.8	12.4		
I-8	16.0	14.9	16.2	16.2	14.7	14.7	13.9	11.2	13.6	12.9	10.8	
R-8			16.5	16.5	15.2	15.2		11.1				
	14.2	12.7	16.0	16.0	14.3	14.3	13.0	10.1	11.6	12.6	8.1	
R-9			15.5	15.5	12.7	12.7	7.5	9.2				
R-10			14.6	14.6				8.6				
R-11			12.7	12.7								
										2nd last R:	13.3	
										last R:	11.2	



The histological observations revealed several characteristics of the sugar distribution. In the vascular rings, sugar was heavily concentrated in the ray parenchyma. The sheath cells around the vascular elements did not appear to contain significant amounts of sugar. In the interzones, sugar was not evenly distributed among the cells but was much more concentrated in some cells than in others. The frequency of cells with high concentrations increased progressively from the interior to about midway to the periphery.

These data conform to the results of Fort and Stout (3) who analyzed whole beets by parts. They found the lowest concentrations, radially in the beet, to be in the paring and the next lowest in the core. The present data also show low concentrations in the outermost rings, which constitute the paring. The concentration in the true core is similar to that in the rings, but the concentration in the first interzone is consistently somewhat less. Fort and Stout's core, according to their diagram, included at least the first interzone, thus their value would be the average of the true core and the first interzone. This average value is also low in the data presented above.

The lack of homogeneity in the distribution of sugar in the beet tissue and the radial pattern of distribution elicits some questions relative to the mechanism of sugar accumulation. Implications with regard to the selection of beets of high potential yields are also present. The beets used in this work were all of the same variety and crop. Beets of other varieties and of very high and very low sugar contents need to be examined before generalizations can be made.

Because the techniques used in the above procedures are not specific for sucrose, the word sugar has been used. However, in the sugarbeet, the proportion of non-sucrose sugars normally present is so small that the effect on these data should be insignificant.

#### Rates of Diffusion of Sugar from Beet Tissue

When discs of sugarbeet tissue are placed in water, sugar diffuses out of the tissue, but at a relatively slow rate. In the course of investigating factors which influence the rate of diffusion, considerable variation occurred. The present data serve to indicate the extent of the variability and to be a guide for procedures which will minimize inherent variation in a particular experiment.

Cylinders were cut from sugarbeets by means of a cork borer and then sliced into discs. The discs used were usually about 10 cm. in diameter and 2 to 3 mm. thick. These were placed in distilled water and stirred by means of magnetic stirrers. Aliquots were removed at intervals and analyzed for sugar content by means of the phenol-sulfuric acid method, and the total sugar content in the solution was calculated.

In mother beets obtained from the American Crystal Sugar Company at East Grand Forks, Minnesota, diffusion after 5 hours ranged from 26.7 to 80.9 mg. of sugar per gram of tissue with most determinations being in the lower half of this range. In beets grown at Fargo, diffusion after 5 hours ranged from 3.3 to 35.9 mg. of sugar per gram of beet tissue. Sugar concentrations in the East Grand Forks beets were about 18 to 19%, and in the Fargo beets were about 9 to 10%. The East Grand Forks beets had been stored in an outdoor cellar; the Fargo beets, in a cold room at 40°F.

Tables 2, 3, and 4 show degrees of variation in diffusion rates among some Fargo beets. Table 4 also shows variation encountered at different locations in the beets. It is evident that considerable variation occurs among beets and also among various locations within the beet. Rates of diffusion tend to be lower in the outer portion of the beet than in the inner portions.

Table 5 shows variations in diffusion rates among discs cut consecutively from the same core. These variations were the least encountered.

Guidelines for selecting discs for diffusion experiments can now be formulated. Consecutive discs are most preferred for minimum variation. If more material is needed, the cylinders of tissue should be cut from the same rings of a beet. When diffusion among different beets is being compared, the tissue should be cut from a similar portion of each beet with respect to vertical and horizontal orientation. Indiscriminate selection of tissue from beets will usually produce a high degree of variation such that differences due to treatments can easily be obscured.

#### Phosphate Fertility Level in Relation to Storage

In 1968, two varieties of sugarbeet seed were planted at four levels of phosphate fertilization. Beet quality was determined at 3 periods after harvesting.

Table 2. Variation among beets in the sugar diffused from discs of tissue in mg sugar per g of beet.

Exp.	Beets	Average Diffusion after 5 hrs	Standard Deviation	Range
	#	mg/g	mg/g	mg/g
1	12	9.3	3.4	3.9-14.1
2	12	8.1	3.5	5.0-15.8
3	12	7.2	2.2	3.3-11.6
Combined	36	8.2	3.1	3.3-15.8

Table 3. Frequency of amounts of diffusion after 5 hr of beets listed in Table 2.

Diffusion: 3	4	5	6	7	8	9	10	11	12	13	14	15	16
(mg sugar per g beet)													
Frequency: 1	1	5	6	6	3	3	2	2	2	2	2	0	1

Table 4. Sugar diffused after 5 hours from discs from various parts of sugarbeets in mg sugar per g of beet tissue. Values are averages of 2 adjacent discs.

Beet No.	Vertical Location	Radial Location		
		Inner	Middle	Outer
		mg/g	mg/g	mg/g
424	high	30.5	18.0	12.7
"	low	35.9	28.2	12.8
417	high	8.4	7.8	8.8
"	middle	14.6	11.9	10.1
425	high	13.2	11.1	7.3
"	low	12.6	12.4	8.1
422	high	7.4	7.6	6.7
"	low	8.1	7.6	4.9
2812	low	18.5	17.1	9.8
2803	low	17.2	16.2	7.9
2802	low	14.5	15.6	8.9
2810	low	12.3	9.4	9.2
2807	low	9.8	9.9	6.8
2806	low	4.6	5.3	5.7

Table 5. Average diffusion after 5 hours from discs of sugarbeet tissue cut consecutively from a single core.

Beet No.	Discs	Ring	Orientation of core	Average Diffusion	Standard Deviation	Range
	#			mg/g	mg/g	mg/g
2809	6	1	vertical	7.6	0.8	6.3- 8.8
"	6	3	vertical	7.9	1.0	6.7- 9.8
2804	6	1	vertical	8.1	1.2	6.5-10.1
"	6	3	vertical	7.3	0.7	6.3- 8.2
2801	6	2	vertical	11.3	1.5	9.6-13.8
"	6	4-5	vertical	8.2	0.8	6.8- 8.9
1506	6	2	vertical	10.3	2.4	7.9-13.0
"	6	4-5	vertical	7.5	1.9	5.5-10.5
1509	12		radial	6.0	0.9	4.4- 7.1
1503	11		radial	6.4	1.3	4.7- 8.7
1510	12		radial	10.5	1.7	8.0-13.0



American #3 Hybrid N and American #3S varieties were used. Original soil phosphate averaged 19 lbs. of P per acre (a rating of medium for this soil). Treatments included 0, 30, 60, and 90 lbs. of P per acre in a split block design replicated eight times.

In October, 60 feet of row were harvested from each plot, yields determined, and the samples split into three approximately equal parts. One part was prepared for analysis immediately. The other parts were stored in a cold room at 40°F. The second part was analyzed in January and the third part in March.

Yields averaged 8.6 tons per acre. Low yield can be attributed primarily to low nitrogen. There were no significant differences among treatments. The other data are presented in Table 6. There appear to be no consistent changes in beet quality relative to phosphate level. Slight increases in values with time of storage can be related to beet dehydration.

#### Acknowledgement

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Table 6. Quality factors of sugarbeets at 4 phosphate levels after 3 storage periods.

Phosphorous lbs. P/A	Storage Period weeks	Sugar %	N ppm	Na ppm	K ppm
<u>Variety: American #3 Hybrid N</u>					
0	0	16.9	213	111	2093
	9	17.3	201	99	2106
	20	18.0	224	105	2329
30	0	16.8	209	109	2023
	9	17.2	191	109	1964
	20	17.5	221	104	2254
60	0	17.0	226	133	2164
	9	17.2	220	111	2110
	20	17.9	248	113	2210
90	0	17.0	196	105	2040
	9	17.4	196	103	2124
	20	17.5	215	86	2285
<u>Variety: American #3S</u>					
0	0	17.0	206	103	1883
	9	17.4	205	104	1991
	20	17.2	229	103	2164
30	0	16.9	218	126	1865
	9	17.4	218	120	1983
	20	17.7	224	124	2078
60	0	16.5	186	113	1753
	9	17.8	196	90	1924
	20	17.8	223	105	2165
90	0	16.3	187	83	1928
	9	17.2	182	103	1934
	20	16.7	196	100	2003

Seedling Diseases, Red River Valley<sup>1/</sup>  
W. M. Bugbee<sup>2/</sup>

In October 1969, soil samples from 13 fields in the southern half of the Red River Valley were assayed with sugarbeet seedlings in the greenhouse. Rhizoctonia, Pythium, and Fusarium were isolated from diseased seedlings. Special efforts were used to isolate Aphanomyces, but without success.

Forty hyphal-tip isolates of Rhizoctonia, representing the 13 fields, are being tested for virulence on seedlings. Various standard methods of inoculation have been tried. The most efficient, so far, is the simple petri plate test. Disinfested seeds of FC-701, FC-702, FC-701/2, FC-702/2, and US-401 were placed on 5-day-old water agar cultures of Rhizoctonia at 25°C. Eight days later, the germination and disease ratings were taken. The disease rating was based on a scale of 1 to 10 with 1 being healthy and 10 dead. These results clearly showed that the FC lines were more resistant than US-401. It also was apparent that the FC-701/2 and FC-702/2 lines were slightly more susceptible than FC-701 or FC-702. So in another experiment I tested FC-701, FC-701/2, and US-401 against a mild (isolate #2) and severe (isolate #16) strain of Rhizoctonia at 10, 15, and 20°C. These results (Table 1) again showed that FC-701/2 was more susceptible than FC-701. But this was most apparent only with the severe isolate at 20°C. At the lower temperatures, the resistance of the FC lines was comparable.

US-401 germinated at a much slower rate than the FC lines at 10°C. This may partially account for its susceptibility to Rhizoctonia.

The nuclear condition of the Rhizoctonia isolates are being examined. The isolates used here, and others observed to date, are multinucleate with dolipore septa. These characters indicate the perfect state is Thanatephorus cucumeris.

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Future work is planned to improve the method of selecting resistance to Rhizoctonia in the seedling stage as well as comparative studies with older plants.

Table 1. The affect of temperature, isolates of Rhizoctonia, and variety on the germination and disease rating (DR) of sugarbeet seedlings in petri dish cultures.

Variety	Isolate and Temperature								
	10 °C			15 °C			20 °C		
	2	16	none	2	16	none	2	16	none
	%-DR	%-DR	%-DR	%-DR	%-DR	%-DR	%-DR	%-DR	%-DR
FC-701	47-1	47-1	40-1	43-2	40-2	38-1	58-1	58-5	58-1
FC-701/2	45-1	55-1	68-1	47-2	33-2	63-1	38-1	53-7	60-1
US-401	18-1	8-1	10-1	30-7	38-7	41-1	25-4	18-7	63-1









